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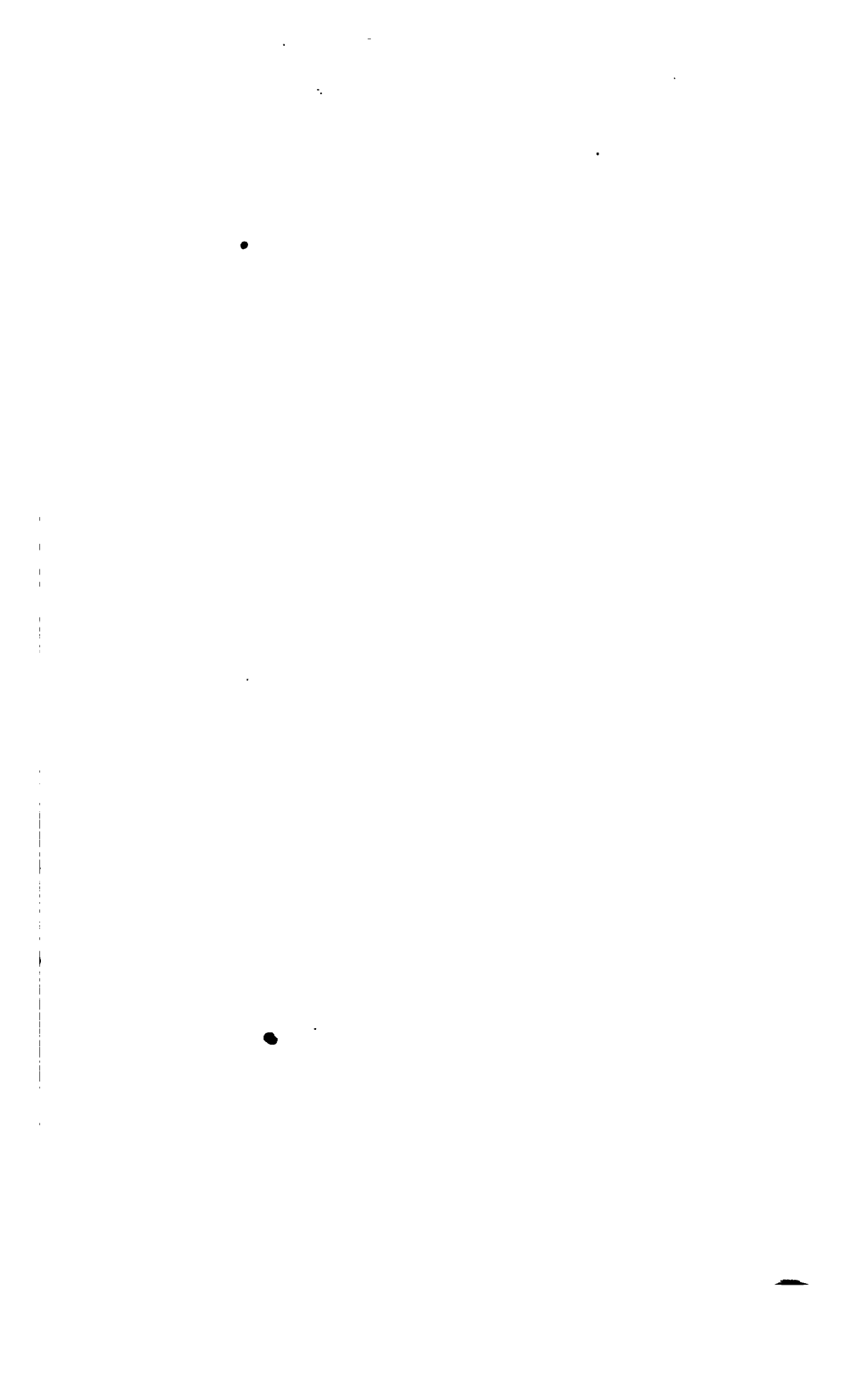
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DUPLICATE.

ANNUAL REPORT
—OF THE—
WYOMING
Agricultural College
—AND—
EXPERIMENT STATION
FOR THE YEAR 1894.

LARAMIE, WYO.
THE REPUBLICAN BOOK AND JOB PRINT.
1894.

EXPERIMENT STATION
Rec'd
ApSw'd

ANNUAL REPORT

—OF THE—

WYOMING

126062

Agricultural College

—AND—

EXPERIMENT STATION

FOR THE YEAR 1894.



CLASSIFIED
EXPERIMENT STATION
Rec'd.....
Ans'd.....

LARAMIE, WYO.
THE REPUBLICAN BOOK AND JOB PRINT.
1894.

4

LETTER OF TRANSMITTAL.

*Hon. Stephen W. Downey,
President Board of Trustees,
Laramie, Wyoming.*

SIR:—I have the honor to submit herewith the Annual Report of the Wyoming Agricultural College, and the Agricultural Experiment Station connected therewith, for the year 1894.

The report will be sent to all similar colleges, the Honorable Secretary of the Interior, and also to the Honorable Secretary of Agriculture, as required by Congressional enactment.

Very respectfully.

A handwritten signature in dark ink, appearing to read "A. A. Johnson". The signature is written in a cursive style with a large, circular flourish at the beginning.

President.

UNIVERSITY OF WYOMING,

Jan. 2, 1895.

THE UNIVERSITY OF WYOMING.

BOARD OF TRUSTEES.

HON. STEPHEN W. DOWNEY, PRESIDENT, Laramie,	1897
GRACE RAYMOND HEBARD, SECRETARY, Cheyenne,	1897
ROBERT H. HOMER, TREASURER, Laramie,	1895
AUGUSTINE KENDALL, Rock Springs,	1895
HON. JOHN D. LOUCKS, Sheridan,	1895
WILLIAM W. BURTON, Afton,	1895
RT. REV. ETHELBERT TALBOT, Laramie,	1895
HON. CHARLES L. VAGNER, Carbon,	1895
ALBERT W. JONES, Casper,	1895
STATE SUPT. STEPHEN T. FARWELL,	<i>Ex-Officio</i>
PRESIDENT A. A. JOHNSON,	<i>Ex-Officio</i>

AGRICULTURAL COMMITTEE.

R. H. HOMER, Chairman,	LARAMIE
S. W. DOWNEY,	LARAMIE
G. R. HEBARD,	CHEYENNE

FACULTY.

A. A. JOHNSON, A. M., D. D., President.
J. D. CONLEY, PH. D., Professor of Physics.
AVEN NELSON, M. S., Professor of Biological Sciences.
HENRY MERZ, A. M., Professor of Political Sciences.
L. C. COLBURN, B. S., Professor of Mathematics and Mechanical Engineering.
E. E. SLOSSON, M. S., Professor of Chemistry.
B. C. BUFFUM, M. S., Professor of Agriculture and Horticulture.
E. C. BULLOCK, 1st Lieut. 7th Cavalry, U. S. A., Professor of Military Science and Tactics.
W. C. KNIGHT, B. S., A. M., Professor of Geology.
CORA M. McDONALD, A. M., Professor of Rhetoric and English Literature.

ANNUAL REPORT
OF THE
WYOMING AGRICULTURAL COLLEGE.
FOR 1894.

In accordance with Congressional enactment, I herewith submit my Fourth Annual Report.

The Wyoming Agricultural College is placed under the control of the Board of Trustees as one of its distinct schools, and by them placed in charge of an Agricultural Committee, as may be seen by reference to the list of Trustees and their organization as given in the introductory pages of this report.

In the introductory pages of this report may also be found the names of the faculty now giving instruction in the Agricultural College. It is due the public to say that some of these Professors occupy similar chairs in the University College of Liberal Arts, and thus a great expense is saved the State by the consolidation of Faculties, and classes when possible, as well as economy of management.

In the Appendix is given the Treasurer's report, the course of study of the Agricultural College, and also the course of study in Mechanical Engineering, to which reference is hereby made. It will be seen by these courses of study that thorough and satisfactory instruction is given, and offered the public, in the Departments

of Agriculture and Mechanical Arts as required by the terms of the law.

It is to be said here, that Wyoming is not an agricultural State, except as that industry is carried on in a limited way by irrigation. Animal industry on the cattle and sheep ranges receives more attention than agriculture. There has yet been developed no interest in dairying and dairy products. Our students, therefore, are not interested especially in these industries. They do not care to pursue courses of study in agriculture. We have, therefore, no students pursuing strictly Agricultural Courses.

As Wyoming has large mineral resources, and is destined to become a manufacturing State, because of its large coal and iron deposits, and precious metals, our students are interested in the Engineering Courses, especially mechanical and mining engineering. In the College of Mechanic Arts we have a number of bright students, and in this department of our work we are making commendable progress.

CONDITION AND PROGRESS.

Our laboratories and the facilities for instruction therein have been improved during the year. Some excellent machinery and tools have been added to the College of Mechanic Arts. The buildings are in good repair and well cared for by efficient janitors.

Progress in the work of instruction has been satisfactory to the management of the University. This year has brought us a better class of students; the scholarship and *esprit de corps* have been commendable. In all it has been a year of encouraging progress.

THE FACULTY.

The teaching force of the College has been somewhat changed during the year 1894. Miss Cora M. McDonald, A. M., succeeds Dr. Antrim as Professor of English Literature and Rhetoric. Henry Merz, A. M., has been added to the Faculty as Professor of Political Science, and W. C. Knight, B. S., A. M., as Professor of Geology.

The quality and condition of the work in the various departments are herewith set forth under their respective heads, and according to the seniority of the various Professors:

PHYSICS.

J. D. CONLEY.

Among the apparatus we have in the Laboratory are the following, viz: Queen's Rotary Air-Pump and a good set of accessories with it. Atwood's Machine, Dynamo, Plunge Battery, Voltmeter, Amperemeter, Spectroscope, Siren, Wheatstone's Bridge, Galvanometer, Geissler Tubes, etc.

The Laboratory is sufficiently large for our present classes. It is well lighted, ventilated and well supplied with water and gas.

The course in Physics consists of five terms' work—two terms during the Second Preparatory year and three terms of the Sophomore year.

The Second Preparatory class uses Avery's Elementary Natural Philosophy for a text-book and pursues during the fall term the general properties of matter—Gravi-

tation, Falling Bodies, Energy, the Simple Machines, Hydrostatics, Specific Gravity, Atmospheric Pressure, etc.

During the second term Heat, Light, Electricity and Magnetism are pursued.

During both terms the text-book work is illustrated by interesting experiments and supplemented by lectures.

The class in Advanced Physics for recitation work have used Ganot's Manual as a text-book and recited three times each week throughout the year, besides working in the Laboratory two hours each week throughout the year. The Physical Library consists of thirty-five volumes, to which each student has access.

BIOLOGY.

AVEN NELSON.

The work in the Department of Biology for the year now closing has been the most satisfactory since the establishment of the College. The more commodious quarters now occupied, the greatly improved facilities as regards apparatus and illustrative material as well as the constantly increasing reference library has led to greater interest on the part of the students.

Work has gone forward along the lines planned for the department and classes have been formed and courses given as per course of study.

With increase in number as well as greater maturity of mind in the students that come to us we may look forward to yet better results.

DEPARTMENT OF MECHANICAL ENGINEERING
AND MATHEMATICS.

L. C. COLBURN.

The studies as laid down in the schedule have been taught during the year; class attendance has been better than in former years and in consequence much better class work has been done.

Lieutenant Bullock has rendered able assistance in the Mathematical Department.

In the Mechanical Department there has been purchased during the past year a boring machine, a mortising machine, a patternmaker's trimming machine and a full set of carving tools. The Department is now completely equipped for pattern making.

The equipment for the Drafting Room has been increased by the purchase of a beamcompass, a set of large triangles and a set of curves.

In connection with Prof. Slosson I have been carrying on special investigation upon the heating values of the coals of the state.

For the coming year an oil testing machine should be purchased so that a full and accurate test of native petroleum can be made.

DEPARTMENT OF CHEMISTRY.

E. E. SLOSSON.

The following courses of study in the Chemical Department of the University of Wyoming are offered to students in the College of Agriculture and Mechanics:

I.—Elementary Chemistry; two terms; fall and win-

ter; three hours lectures and recitations and four hours laboratory work a week. The aim of this course is to give students a knowledge of the laws of chemical change, a practical familiarity with the principal elements and compounds and skill in the manipulations of apparatus.

II. Qualitative Analysis; laboratory work ten hours a week, any term. Open to students who have taken Course I.

III.—Quantitative Analysis; laboratory work ten hours a week, any term. Open to students who have taken Courses I. and II.

IV.—Organic Chemistry; spring term, lectures and recitations three hours and laboratory work four hours a week. A theoretical and practical study of the carbon compounds with special reference to the composition and relative value of foods. Open to students who have taken Course I.

V.—Agricultural Chemistry; lectures and laboratory work on the chemistry of plant growth and the application of chemical principles to practical agriculture with special reference to the problems of the arid region; one term.

There has been projected for some time a series of bulletins to be issued by the University on the mineral resources of Wyoming with intention of doing for the mining interests of the state what the Agricultural Experiment Station has done for Wyoming agriculture. The first of the series is now almost ready for publication, and will give the composition and relative heating powers of all important coals of Wyoming, as well as some interesting facts in regard to the utilization of our crude petroleum for fuel. Until recently there has been no conveni-

ent and accurate method of determining the heating value of a fuel. No dependence can be placed on the heating value as calculated from the results of proximate analysis and even the more difficult ultimate analysis gives little better values. The instrument generally used in the determination of heating value, the Thompson calorimeter, gives, as is well known, very inaccurate results. The only apparatus giving sufficiently exact heats of combustion was Berthelot's bomb calorimeter in which the fuel is burned in oxygen under a pressure of twenty-five atmospheres. The great cost of this, \$1500, has prevented its common use, but a modification has been devised in which the bomb is lined with porcelain instead of platinum, and the cost of the whole apparatus reduced to about \$500. This instrument has been purchased by the University, and Prof. Colburn and I have made with it about one hundred determinations of the heating power of Wyoming coals and oils.

AGRICULTURE AND HORTICULTURE.

B. C. BUFFUM.

The studies in Agriculture and Horticulture remain the same as those offered last year. Instruction is given by lectures and supplemented by field and laboratory work. During the year a small greenhouse has been added to our equipment which will facilitate the work by furnishing a place in which to carry on investigations during the year and some material with which to work.

Attention is called especially to our shorter courses of instruction, which will be of practical benefit to anyone engaged in agricultural or horticultural pursuits.

A course in the science and practice of irrigation is offered to those who wish instruction in this important branch.

MILITARY SCIENCE AND TACTICS.

E. C. BULLOCK, FIRST LIEUT., 7TH U. S. CAVALRY.

The total number of students who have received military instruction has been by terms, as follows :

Winter term.....	45.
Spring term.....	31.
Fall term.....	45.

They have, as a rule, reported four times a week.

The consolidation of the two cadet companies into one, referred to in my last report, still continues.

Our equipment remains the same as noted in my last report, except an addition of thirty cavalry sabres and belts.

Instruction, wherever practicable, has been both practical and theoretical and may be classified as follows :

Infantry.—Schools of the soldier, squad and company in close and extended order.

Guard mounting and duty as sentinels by day.

Small arms firing.—Position, aiming, and sighting drills; gallery practice with reduced charges, and range practice with service cartridges at 100, 200 and 300 yards.

Artillery.—Standing gun drill with blank cartridges.

Cavalry.—Manual of the sabre, dismounted.

Military Signalling.—With flags for those in their second and subsequent years in Military Department. With heliograph for all cadets in college proper.

RHETORIC AND ENGLISH LITERATURE.

CORA M. M'DONALD.

In submitting a report of the work in English for the year 1894, permit me to state that I have had charge of this department during the last term only. My predecessor, Dr. E. I. Antrim, resigned late in June, 1894, and it was thought best for me to continue, for the present, the course laid out by him.

In the Sub-Preparatory course, English Grammar is studied during the fall term, and Elementary Rhetoric during the winter and spring terms. Extracts from standard American authors are read in class.

In the Preparatory year of the Mechanical course and in the Freshman year of the Agricultural course three hours' work in Lessons in English is required each week.

In the Junior year of the Agricultural course, English Literature and Literary Criticism are studied during the fall and winter terms.

In the Mechanical course, English Literature occupies five hours of the week during the fall term of the Senior year.

Public speaking and English Composition receive much attention throughout the courses.

The students are divided into sections, each of which meets the Professor of English for literary exercises once a month. In addition to this, the Mechanical course calls for a thesis, and the Agricultural course requires a thesis, speeches and essays upon special subjects.

It is hoped to place additional work in English in all the departments of the University. Courses in required reading outside of class will be recommended at the opening of the year 1895.

I am greatly indebted to Prof. E. E. Slosson for valuable advice and assistance in my department.

GEOLOGY.

W. C. KNIGHT.

The department of geology offers more than ordinary opportunities to those who desire to pursue this study. The regular college course requires five hours per week for three consecutive terms.

The work is arranged as follows : First term, a comprehensive review of the Elements of Geology. Second term, Minerology and Paleontology. Third term, Economic Geology. A text-book is used, but all work is supplemented with lectures on all important themes, and a careful study of rocks and fossils. The following books are used as a text : Dana, LeConte, Winchell, Williams, Kemp, and Nicholson.

Besides the regular course, studies in Advanced Geology are offered to those who wish to make a specialty of this branch. For the benefit of those who wish to become thorough Geologists, the following inducements are offered :

In order to become proficient in this study, the student must do work for himself in the field, and in this respect the University of Wyoming is as favorably located as any school in the world. On the east of the University are the Laramie Mountains; on the west, the Medicine Bow Mountains, both ranges having large exposures of Archean rocks, Flanking these mountains are a series of Paleozoic and Mesozoic rocks, and only twenty miles away is a very extensive field of Tertiary. The Archean furnishes

a fine field for economic research, it being mineral bearing in both ranges. The sedimentary rocks are rich in vertebrate and invertebrate fossil life, and also have valuable deposits of clay, gypsum, soda and coal. The close proximity to mines of gold, silver, copper, lead, graphite, bismuth and coal, and the nearness of quarries of granite marble, lime and sandstone makes this location one of great value to the student of Geology.

There are in the course of construction two Geological maps, one of the entire state, and one of the immediate vicinity of the University, especially adapted for the assistance of students.

LIBRARY.

G. R. HEBARD.

There have been added to the library, during the year 1894, 374 bound volumes and 400 pamphlets.

We have on our files 47 periodicals for which we subscribe, including agricultural, mining, scientific and economic papers and 58 newspapers on our exchange list.

The students have access to all departments of the library and are showing an increased interest in this department of the University.

The larger part of the library is composed of technical books and books of reference, making it to a great degree a working library for Professors and students.

The University uses the Dewey Decimal Card Catalog system, and in addition to the regular cards we have those coming from the Department of Agriculture at Washington, containing a complete list of publications sent from that department and its several branches in connection with the Experiment Station work.



APPENDIX.

- I. Courses of Study.
 - II. Treasurer's Report.
-

COURSES OF STUDY.

The College of Agriculture, State of Wyoming, was reorganized at the opening of the present University year, with additional buildings, laboratories and instructors, and now offers to the youth of Wyoming the following courses of instruction in Agriculture, Mechanic Arts and Military Science :

I. A ONE YEAR'S COURSE.

For those whose time is limited, but who wish some practical instruction in farming and ranching. The studies are so arranged that students from the district schools can enter at the beginning of any term. The recitations and lectures are with the regular University classes, a certificate is given for work done, and the grades may be credited toward the longer courses. The fall term includes : Book-Keeping or Physiology, Drawing, English Grammar or Rhetoric, Arithmetic or Algebra, and Wood Working. The winter term embraces : Book-Keeping or Physical Geography, History and principles of Agriculture, Botany or Horticulture, Arithmetic or Algebra, and Metal Working. The spring term is devoted to : Book-Keeping or Civil Government, the Agriculture of Soils and Tillage, Botany or Horticulture, Zoology or Geometry, and Field and Laboratory Work.

II. A TWO YEARS' COURSE.

Including the above, and selected studies from the second and third years of the complete course.

III. A FOUR YEARS' GRADUATING COURSE.

Devoted to a thorough training in Agriculture. (See course of study.)

IV. A GRADUATE COURSE.

For graduates who wish to devote their time to special research in the fields and laboratories of the Agricultural Experiment Station.

SPECIAL CHEMICAL STUDENTS.

The chemical laboratory is fitted up with a view to making it as useful as possible to the State at large, and good opportunities are offered for carrying on special investigations, or courses of study. Prospectors who wish to take a course in Determinative Mineralogy, pharmacists who desire to perfect themselves in Chemistry before taking examinations or going away to a school of pharmacy, and especially those contemplating the establishment of some industry developing the natural resources of Wyoming, will be given every available facility for their work. The study being individual and not in classes, hours can generally be arranged to suit the student. The only requirement is sufficient previous knowledge to undertake the line of work desired. Tuition is free; apparatus broken and chemicals used are charged at cost.

EXPENSES.

Tuition is free to all resident students of Wyoming; non-residents will be required to pay an annual fee of \$5.00. An incidental and library fee of \$2.50 a year must be paid by all students.

SCOPE OF THE COLLEGE.

The College of Agriculture is designed to give to young men, who may desire it, the advantages of a thor-

ough, liberal and practical education, not only to prepare them for the successful prosecution of agriculture in all its branches, but to secure to the student the mental discipline and training necessary to qualify him for any other calling or profession, and fit him to discharge intelligently the duties of an American citizen. The period of study requisite for graduation will extend through four years.

Students completing the course will receive the degree of Bachelor of Agriculture, and such students pursuing one year of graduate studies in the University will receive the degree of Bachelor of Science.

REQUIREMENTS, FOR ADMISSION.

Students will be admitted to the Agricultural course by passing a satisfactory examination in Arithmetic, English Grammar and Composition, Physiology, United States History, Physical Geography and Elementary Algebra.

COURSE OF INSTRUCTION.

The instruction in this College will be given at the University building, and the practical instruction will be given on the Agricultural College farm and at the Experiment Station at Laramie.

AGRICULTURAL COLLEGE COURSE.

FRESHMAN.			Algebra	General History	Physics	Drawing	English, 2 hours Shop work, 2 hours
FALL TERM			Algebra		Physics		
WINTER TERM			Algebra	Agriculture	Physics	Botany, I.	Rhetoricals
SPRING TERM			Algebra	Agriculture	Physics	Botany, I.	Rhetoricals
FALL TERM			Algebra	Advanced Physiology Anatomy	Chemistry, I.	Botany, II.	Botanical Essays
WINTER TERM			Plane Geometry	Agriculture	Chemistry, I.	Zoology, I.	Agricultural Essays
SPRING TERM			Solid Geometry	Landscape Gardening	Chemistry, II.	Zoology, II.	Essays
FALL TERM			Plane Trigonometry	Psychology	English Literature	Irrigation	Essays—Speech
WINTER TERM			Mechanics	Logic	Literary Criticism	Meteorology	Horticultural and Physical Essays
SPRING TERM			Spherical Trigonome- try. Surveying	Agricultural Chemis- try	Agricultural En- gineering	Entomology	Agricultural and En- tomological Essays Speech
FALL TERM			Political Economy	Horticulture	Veterinary	Geology	Political Economy Es- says, Speech
WINTER TERM			International Law	Astronomy	Veterinary	Geology	Technical Essay Speech
SPRING TERM			Thesis	Horticulture	Organic Chemistry	Mineralogy	Oration

Military drill the same as in other courses. Afternoons and two hours for laboratory and field work. To lead to degree of B. Agr. Graduate courses leading to degree of B. S. or M. Agr.

College of Mechanic Arts.

ADMISSION.

Students will be admitted to the Mechanical course by passing a satisfactory examination in Arithmetic, English Grammar and Composition, Physiology, United States History, Physical Geography and Elementary Algebra.

SPECIAL INSTRUCTION IN THE MECHANICAL DEPARTMENT.

All desiring special instruction in Mechanical Drafting, Higher Theoretical Mechanics and Engineering, should examine the new course of study in the Mechanical Department. Mechanical Drafting can be commenced in any term and be pursued as rapidly as the skill of the student will permit, as all work depends solely upon the student's ability.

Any branch of the higher mechanics can be pursued if the elementary principles are well understood by the student.

MECHANICAL COURSE.

	FALL TERM.	WINTER TERM.	SPRING TERM.
PREPARATORY.	Algebra, 5	Algebra, 5	Algebra, 5
	Elementary Physics	Elementary Physics	
	English, 3	English, 3	English, 3
	Mechanical Drawing	Mechanical Drawing, 5	Freehand Drawing
	Rhetorical work the same as other courses Shop work two hours each afternoon.		
FRESHMAN.	Algebra, 3	Geometry (Plane), 5	Geometry (Solid), 5
	French or German, 5	French or German, 3	French or German, 5
	Mechanical Drawing, 5	Descriptive Geometry, 5	Kinematic Drawing, 5
	Rhetorical work the same as other courses. Shop work two hours each afternoon.		
SOPHOMORE.	Plane Trigonometry, 5	Elementary Mechanics, 5	Spherical Trigonometry and Surveying, 5
	French or German, 5	Chemistry, I., 5	Mechanical Drawing
	Chemistry, I., 5	French or German, 5	French or German, 5
	Rhetorical work the same as other courses. Shop work two hours each afternoon.		
JUNIOR.	Advanced Physics, 5	Advanced Physics, 5	Advanced Physics, 5
	Analytical Geometry	Differential Calculus, 5	Integral Calculus, 5
	Chemistry of Metals, 5	Elements of Mechanism, 5	Machine Design, 5
	Technical reading from engineering magazines and papers once per week.		
SENIOR.	English Literature, 5	Mechanics of Materials, 5	Thermodynamics, 5
	Analytical Mechanics, 5	Steam Engine, 5	Hydraulics, 5
	Machine Drafting, 5	Astronomy, 5	Thesis work.
	Laboratory work in engineering in afternoon.		

Shop work each term, during entire course, in wood shop, blacksmith shop, foundry and machine shop. Military drill each term during first two years. This course leads to B. E.
A two years' Graduate leads to M. E.

Treasurer's Report.

UNIVERSITY OF WYOMING,)
LARAMIE, WYOMING, June 30, 1894. }

Report of Treasurer of said institution, to the Secretary of Agriculture and the Secretary of the Interior, of amount received under act of congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts, and of the disbursement thereof, to and including June 30, 1894:

Balance on hand July 1, 1893.....	\$ 3,253 62
Date of receipt of installment for 1893-'94, September 11, 1893.....	19,000 00

Total available for year ending June 30, 1894...	\$22,253 62
Disbursement thereof for and during the year ending June 30, 1894—	

Agriculture.....	\$ 1,819 67
Mechanic Arts.....	5,002 09
English Language.....	3,486 23
Mathematical Science.....	1,025 31
Natural or Physical Science.....	6,470 54
Economic Science.....	2,675 05

\$20,478 89

Balance remaining unexpended July 1, 1894.....	\$ 1,774 73
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I hereby certify that the above account is correct and true, and truly represents the detail of expenditures for the period and by the institution named, and that said expenditures were applied only to instruction in Agriculture, Mechanic Arts, the English language, and the various branches of Mathematical, Physical, Natural and Economic Science, with special reference to their applications in the industries of life, and to the facilities for such instruction.

ROBERT H. HOMER,
Treasurer.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

FOURTH ANNUAL REPORT

1894.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

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GRACE RAYMOND HEBARD, SECRETARY, Cheyenne,	- - -	1897
ROBERT H. HOMER, TREASURER, Laramie,	- - -	1895
AUGUSTINE KENDALL, Rock Springs,	- - -	1895
HON. JOHN D. LOUCKS, Sheridan,	- - -	1895
WILLIAM W. BURTON, Afton,	- - -	1895
RT. REV. ETHELBERT TALBOT, Laramie,	- - -	1895
HON. CHARLES L. VAGNER, Carbon,	- - -	1895
ALBERT W. JONES, Casper,	- - -	1895
STATE SUPT. STEPHEN T. FARWELL,	- - -	<i>Ex-Officio</i>
PRESIDENT A. A. JOHNSON,	- - -	<i>Ex-Officio</i>

AGRICULTURAL COMMITTEE.

R. H. HOMER, Chairman,	- - -	LARAMIE
S. W. DOWNEY,	- - -	LARAMIE
G. R. HEBARD,	- - -	CHEYENNE

PRESIDENT OF THE UNIVERSITY OF WYOMING.

A. A. JOHNSON, A. M., D. D.

STATION COUNCIL.

A. A. JOHNSON, A. M., D. D.,	- - -	DIRECTOR
G. R. HEBARD, A. M., PH. D.	- - -	SECRETARY
B. C. BUFFUM, M. S.,	- - -	AGRICULTURIST AND HORTICULTURIST
J. D. CONLEY, PH. D.,	- - -	PHYSICIST AND METEOROLOGIST
AVEN NELSON, M. S., A. M.,	- - -	BOTANIST
E. E. SLOSSON, M. S.,	- - -	CHEMIST
W. C. KNIGHT, A. M.,	- - -	GEOLOGIST

SUPERINTENDENTS.

LANDER EXPERIMENT FARM,	- - -	JACOB S. MEYER
SARATOGA EXPERIMENT FARM,	- - -	JOHN D. PARKER
SHERIDAN EXPERIMENT FARM,	- - -	JOHN F. LEWIS
SUNDANCE EXPERIMENT FARM,	- - -	E. A. HOYT
WHEATLAND EXPERIMENT FARM,	- - -	MARTIN R. JOHNSTON

WYOMING UNIVERSITY EXPERIMENT FARM, - - - B. C. BUFFUM, SUP'T
 WYOMING UNIVERSITY EXPERIMENT GROUNDS,
 THE HORTICULTURIST IN CHARGE

FOURTH ANNUAL REPORT

—OF THE—

WYOMING AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR 1894.

REPORT OF THE DIRECTOR.

This report is confined to the completed work of the Station, for the year 1894 ; and the financial statement of the fiscal year, ending June 30th, 1894. Questions of practical importance to farmers, fruit growers and stockmen of the State have received the attention of the Station workers ; and experiments and investigations are being carried forward with special reference to advancing scientific agriculture in Wyoming, in harmony with conditions prevailing in the arid regions.

The completed work of the year is contained in four Bulletins, and a full text of each appears in the succeeding pages of this report, and to which reference is hereby made.

The Bulletins and their subject matter are as follows:

BULLETIN NO. 17.—Crop Report for 1893.—Cost and Profit of Growing Wheat.—Sugar Beets.—Garden Vegetables and Tobacco.—Progress Report on Fruits and Trees.—Meteorology for 1893.

BULLETIN NO. 18.—The Reclamation of Arid Lands.—The Harvey Water Motor.

BULLETIN NO. 19.—Squirrel-Tail (Fox-Tail) Grass—One of the Stock Pests of Wyoming.

BULLETIN NO. 20.—Artesian Wells of Southern Wyoming—Their History and Relation to Irrigation.

The Station is now well equipped with apparatus and facilities for scientific work; and its staff of workers is more experienced and better acquainted with the conditions affecting the agricultural interests of the State than heretofore. It is believed that this fact will make the experiments under way more comprehensive, and of greater value to the State.

The Station is becoming better known to our farmers, as indicated by the increase in correspondence, and applications for Bulletins. I have endeavored to secure the names of intelligent farmers and ranchmen in the State and add them to our mailing list, so that our Bulletins may reach those who are likely to be benefited by them.

AGRICULTURAL EXPERIMENTS FOR 1894.

The outline of general experiments as carried forward on the Experiment Farms for 1894 are as follows:

1. Repeat the experiments of 1893 in cereals and root crops with home grown seed. Reduce the amount of land occupied in this experiment, one half less than that used in 1893. For this experiment use various fertilizers, noting the effect on the character of the soil, and the yield of crops.

2. Continue experiments in rotation of crops in the following order: Follow root crops with a crop of wheat or rye, then follow wheat or rye with some kind of forage

plant. Try red clover as the forage plant, and plow the same under in the fall, in order to add nitrogenous matter to soil as a fertilizer. This experiment in rotation of crops will need to be observed and kept up for at least three years, carefully noting the effect upon the soil.

3. Take an acre plat for spring wheat, keep an accurate account or record of the cost of producing this. This can be done by noting the time occupied in planting and harvesting the same at regular wages. The object of this experiment is to find the approximate cost of raising wheat. Keep an accurate record of the amount of grain produced on said acre. This with the market price per bushel, will enable you to report the profit derived from raising spring wheat.

4. As potatoes are likely to become a staple crop in Wyoming, begin an experiment of a test of varieties on one-half acre. One row for each variety across the one-half acre the short way. Seed will be furnished the Superintendent. This experiment will be continued for three years. (See special instructions.)

5. Experiments to test the best methods of cultivating, and best varieties of the following farm crops: Winter wheat, spring wheat, winter rye, spring rye, oats, buckwheat, field peas, flax, hops, corn, millet, timothy, and English rye grass.

6. SPECIAL LINES.—Flax with reference to character of fiber and seed. Hops on farms of altitudes of 5,000 feet and under. English rye grass on alkali lands.

OUTLINE OF WORK IN PROGRESS.

The work of the station now in progress may be stated as follows:

1. Collection and determination of the flora of the State.
2. Physical properties of the soils of Wyoming are being investigated.
3. Analyses of irrigation waters. Analyses and calorimeter tests of foods.
4. Effects of alkali in soil upon seed germination.
5. Cost and profit of growing wheat by irrigation.
6. Special test of varieties of onions and potatoes.

The Station Council has held regular monthly meetings and special meetings when necessary.

The report of the treasurer is herewith made a part of this report, to which attention is invited, showing that the funds of the station are expended in harmony with the enactment of Congress.

The reports of the Station Workers, together with the four bulletins issued by the Station, are herewith submitted.

Respectfully,

A. A. JOHNSON,

Director.

ANNUAL STATEMENT OF AGRICULTURAL EXPERIMENT STATION FUND

FOR THE YEAR ENDING JUNE 30, 1894.

Cash received from the United States	\$15,000 00
" " " sale of crops from farms	263 27
Total amount received	\$15,263 27
Cash paid, Salaries	\$7,715 99
" Library	15 65
" Labor	3,558 22
" Postage	90 53
" Freight, Express	189 98
" Printing	1,286 94
" Building	418 00
" Supplies	543 19
" Scientific Instruments	588 83
" Traveling Expenses	470 63
" Incidental Expenses	385 31
	\$15,263 27

LARAMIE, Wyoming, July 2, 1894.

I, the undersigned, duly appointed one of the auditors for the corporation, do hereby certify that I have examined the books and accounts of the Experiment Station of the University of Wyoming for the fiscal year ending June 30, 1894, and have found the same well kept and correctly classified as above, and that the receipts for time named are shown to be \$15,263.27 and the corresponding disbursements \$15,263.27. All of the proper vouchers are on file and have been by me examined and found correct, and there is no balance to be accounted for in the fiscal year ending June 30, 1894.

AUGUSTINE KENDALL,
Chairman Auditing Committee.

LARAMIE, Wyoming, July 2, 1894.

I hereby certify that the foregoing is a true copy of

the books of accounts of the Experiment Station of the University of Wyoming.

ROBERT H. HOMER,
Treasurer.

LARAMIE, Wyoming, July 2, 1894.

I hereby certify that Robert H. Homer is the Treasurer of the Board of Trustees of the University of Wyoming and that the above is his signature.

A. A. JOHNSON,
President of the University of Wyoming.

REPORT OF THE AGRICULTURIST AND HORTICULTURIST.

B. C. BUFFUM.

The amount of routine labor and office work has steadily increased in this department, being heavier than in previous years.

Bulletin No, 17, for March, 1894, with the exception of Part 3, written by the Chemist, was compiled from the reports of the Superintendents of the several Farms. I also wrote Part 6, giving in condensed form the meteorological records for last year.

Having been relieved of the work in meteorology in March by its being transferred to the Department of Physics, I was made Agriculturist at the June meeting of the Board of Trustees, and all the work upon the Laramie Farm was placed in my charge. F. J. Niswander, the former Superintendent, had the agricultural work well under way. H. S. Kendall, B. S., was obtained as foreman on June 8th. His efficient help made it possible to carry on the farm work and furnish more complete notes

and data than heretofore. Three hundred and twenty-six varieties of crops were grown. The principal experiments were upon cost and profit of growing wheat, variety tests of onions and potatoes and sowing turnips with drill versus broadcast. The season was more favorable than any since the Station was established. Plenty of water was furnished for irrigation, and no crop suffered serious damage from plant diseases or the depredations of injurious insects. Gophers did some damage, but were held in check successfully by frequent applications of carbon bisulphide.

The few failures we have to report furnish conclusive evidence that such crops as failed cannot be grown successfully under our conditions of soil and climate. On the other hand, the long list of crops which can be grown successfully, produced good yields and of excellent quality. Measurements of the water used in irrigating were continued to determine its duty.

I believe the initiative work of the Station may be considered finished. We have now furnished data showing which of the staple crops can be raised successfully in the different sections, and in the future will be able to turn more of our attention to special lines of investigation.

In August the construction of a small greenhouse, 18x25 feet, with work room 9x14 feet, was commenced. It was completed October first. Some plants have been donated by friends of the University and others purchased. The stock has been increased until the house is nearly full. We hope to have some material with which to decorate the campus next season. The house is small and will hardly supply our needs another year, though it furnishes a place to carry on some important investigations.

During the season I have collected and obtained through the collections others have made for me, between nine and ten thousand specimens of insects, some birds and other natural history specimens. Professors Knight and Nelson, in their trip over the State, made valuable collections of insects, which are now in my possession. Specimens of each species will be placed with the collection in the University or in the Museum as soon as I am able to have them determined.

I take pleasure in stating that my department is in better condition than ever before and in thanking those from whom courtesies have been extended.

REPORT OF PHYSICIST.

J. D. CONLEY.

I was appointed Physicist on the Station Council in the summer of 1893, and outlined as my first work the study of the Artesian Wells of Southern Wyoming. Bulletin No. 20, incorporated in this annual report, gives the result of my investigations. The subject now under investigation is the Physics of the Soils of Wyoming.

We believe that the facts thus ascertained, together with a soil map of the State, will make a desirable bulletin for our new commonwealth and will be of usefulness to the Agricultural Department, as well as a valuable contribution to science.

REPORT OF METEOROLOGIST.

J. D. CONLEY.

I took charge of Meteorology in March, 1894, and commenced at once, with the help of my assistant, to get up tables for the dew point and relative humidity for this high altitude, putting into a condensed and readable form the observations of the past three years. We trust that these observations will be of sufficient interest and value to justify their publication with other observations in a future Bulletin on Meteorology. Careful records have been kept of the same phenomena which have been in progress for the past three years, with some additions during this year.

In September we set up a steel tower 64 feet high and at a distance of over 300 feet from the building as a support for a new wind-vane. We also placed the anemometer upon an arm of the support for the wind-vane. These are both connected by a cable with a new quadruple register purchased from Julien P. Friez, Baltimore.

Our records are now perfectly reliable, and when worked up will be of great interest to the agriculturist, and also of value to the scientific world.

Daily records are kept of the precipitation, maximum and minimum temperature, and the sunshine record by the Superintendents of the Experiment Farms at Lander, Saratoga, Sheridan, Sundance and Wheatland. There are also nine volunteer observers situated in various parts of the state who report monthly the precipitation of their localities, and some of them report the temperature taken twice a day.

REPORT OF THE BOTANIST.

AVEN NELSON.

The botanical work of the Station has been carried on along the lines previously planned for the year.

The most important undertaking at present under way, is the botanical survey of the State, and connected therewith the building up of the herbarium.

The collection and determination of the plants of the State have been in progress some little time, but in so large a State one worker cannot hope to make even an approximately exhaustive survey short of several years. During the past season the work has been pushed with all the energy and time that remained after other imperative duties had received attention. While the school terms were in progress more than 300 species were collected about Laramie and in her neighboring hills, while as a result of the special

COLLECTING EXPEDITION

upwards of 700 species more were added, making the season's collections probably close to 1100 species. A large part of this material was collected in duplicate; in fact in every case where the material was obtainable, five to thirty or more specimens were prepared. This will make it possible to add to the herbarium a very large number of specimens by exchange. Many exchanges have already been arranged and will be executed just as soon as the material can all be determined and classified. This work is going forward as rapidly as the time available will allow. With class work and with the preparation of bulletins and attention to the correspond-

ence which the needs of the department necessitate, it leaves only the smaller end of the day for this important work. I hope, however, to work the material and get out the exchanges before the present school year closes.

The before-mentioned collecting expedition left Laramie July 7, and consisted of the following members: Prof. Knight and Mr. W. H. Reed, who collected in geology and mineralogy; the botanist and his assistant, Mr. George Cordiner, who proved himself an interested and efficient helper. The geographical range covered by the expedition was, briefly: Laramie to Lusk on the east, westward and northward to Lander, thence to the head of the Wind river, over the Wind River range to Jackson's Hole and the Tetons, back by way of Green river to South Pass.

At the latter place the botanist was obliged to leave the expedition, returning to Laramie Sept. 5. His assistant, however, secured a number of species of the later flora before the return of the party to Laramie on Sept. 24. Unfortunately these later specimens were all destroyed by the burning of a car in the Laramie yards. Notwithstanding this loss the amount of material secured is unprecedented if the time occupied by the expedition is taken into account.

During the year the following bulletins have been prepared:

Issued in September, Bulletin No. 19,

SQUIRREL-TAIL GRASS.

The feeding of squirrel-tail hay, or hay containing the same, results not only in inflammation of the mucous

membrane of the mouth of the animal, but prolonged use results in swelling and suppuration of the gums, ulceration and enlargement of the jaw-bones, absorption of the bony tissue of the same and of the roots of the teeth.

The spread of this pest is due more largely to wrong methods of irrigation than to any other cause. It must be combatted by a return to rational methods and by preventing the formation of seed for a year or two.

There was also issued in September a press bulletin on the

RUSSIAN THISTLE.

It dealt with the facts of its introduction, its botanical character and structure, the means of its distribution, the trouble arising from its dispersion and the means for its suppression.

Not yet issued, but well under way, is a bulletin on the cause and prevention of smuts in grains. This fungous disease is reported as quite prevalent in all the grain-growing districts of the state, and information concerning the best means for its prevention will undoubtedly be welcomed.

Notes on weeds, native and introduced, are being accumulated, and will lead to a bulletin on that subject sometime in the future.

Many minor matters have received attention, some of which are preliminary to and intended to facilitate future results in the botanical work of the Station.

REPORT OF THE CHEMIST.

E. E. SLOSSON.

During the year a large number of water analyses have been made, and a bulletin will be issued this winter giving the composition of the most important irrigation waters in the State, including also some mineral springs outside of the National Park.

A bomb calorimeter for the determination of the potential energy of foods and fuels has been purchased and its constants determined. As soon as the work now on hand is disposed of I will analyze and determine the potential energy of some line of food products. Tests made during the last three years have shown that adulteration of food products in the Wyoming markets is quite common. In the absence of State laws on the subject, it is desirable that the people be given such protection from impure food as the exposure of such cases can afford. I will be glad to test free of charge any food product suspected of adulteration which is sent to the Station for examination.

Fertilizer field tests have been planned for two of the Experiment Farms, and a few samples of sugar beets have been analyzed during the year.

REPORT OF GEOLOGIST.

WILBUR C. KNIGHT.

The geologist of the Station spent the entire summer studying the Laramie, Rattlesnake, Wind River and Gros

Ventre mountains, endeavoring to ascertain some new method of supplying arid regions which have no natural water supply with water for irrigation purposes, and also to augment the supply of those localities which are held back on account of no water in the latter months, when it is so much needed. The result of the investigation has been highly satisfactory and will be prepared for a bulletin as soon as possible.

The study of wind erosion has been continued during the year, but the work has not advanced far enough to furnish the public with any valuable information. The geologist will pay special attention during the coming year to the study of wind erosion and the production of soils in the arid regions.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 17.

MARCH, 1894.

- I. Crop Report for 1893.
 - II. Cost and Profit of Growing Wheat.
 - III. Sugar Beets.
 - IV. Garden Vegetables and Tobacco.
 - V. Progress Report on Fruits and Trees.
 - VI. Meteorology for 1893.
-

BY THE HORTICULTURIST AND THE CHEMIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

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WYOMING UNIVERSITY EXPERIMENT FARM, - - F. J. NISWANDER, SUP'T
 WYOMING UNIVERSITY EXPERIMENT GROUNDS,

THE HORTICULTURIST IN CHARGE

Introductory Note.

B. C. BUFFUM.

This bulletin is published to give, as briefly as possible, the results of work carried on by the Station in the sections of Agriculture, Horticulture and Meteorology not published elsewhere. It is largely a progress report. As the conditions of soil, climate and treatment unavoidably vary each year, none of the results given can be regarded final. It is thought, however, that they may be of interest and value as far as the present data indicate the adaptability of different varieties tested to the soil represented by each Experiment Farm. To make the work of the Experiment Station of immediate practical value to our people who are just beginning the change from the early range stock business of the west and extensive farming to smaller operations and intensive methods, we have been obliged to repeat much of the work already accomplished in other states, doing a large amount of general first work. In these initiative operations it has been necessary for the Station to establish the possibility of raising at all many of our common crops, without reference to special lines of technical work of interest to science.

The newness of fruit raising in the state has prevented our making reports upon varieties. Several years are necessary to furnish materials for observation before

we can get on our feet and be in a position to advance scientific horticulture.

All notes of value regarding crops raised on each of the Experiment Farms during the season of 1893, or crops, the yields of which were determined, are given in the following report upon Farm Crops and Garden Vegetables. The special test of onions, carried on the past season, will be repeated the coming summer and the results published in a future bulletin.

The results with grasses and forage plants were given in Bulletin No. 14, and are omitted from this report, with the exception of non-saccharine sorghums.

Prof. E. E. Slosson has prepared the article upon sugar beets, and I have been greatly assisted in the rest of the work by the superintendents of the Experiment Farms, who furnished special data, and Mr. Fred Nelson, assistant in Meteorology. Thanks are also due Mr. F. J. Niswander for carrying on the horticultural work on the Laramie Farm during my absence the past summer.

Crop Report for 1893.

B. C. BUFFUM.

The crops for the season of 1893 were not so heavy as usual in any part of the state. The unfavorable climatic conditions as given in the Meteorological section of this bulletin, in connection with the fact that in many places the necessary water for irrigation could not be obtained when most needed, are sufficient explanation of the causes. No satisfactory results were obtained on the Laramie Farm. The experiments will be repeated the coming season with little modification. Potatoes gave the most satisfactory results of the year. Careful experiments with this important product will be carried on at each of the Experiment farms alike for two or more years. The experiments in the cost and profit of growing wheat, and with flax, will be repeated, also, several seasons to verify results and determine the place and value of these crops in the state.

LARAMIE.

Of thirty-six varieties of farm crops planted. only the potatoes furnished any yield. The failures were general and due to the lack of water for irrigation from June 8 to 20, on account of the ditch being broken. The ground being unusually dry, water was needed at this time to germinate the seed and insure a crop. This with existing climatic conditions proved disastrous to the Laramie Farm. White Russian Wheat was ripening in places at

the time of frost but had been so stunted in its early growth that it was valueless. The ground was so dry that other varieties of wheat and oats, barley, rye, carrots and rutabagas either did not come up at all, or were retarded and destroyed soon after coming up. Some of the potatoes planted May 10, did not come up till June 26. The Early Maine, the first up, did not appear till June 2. All were irrigated twice in July, were frosted Sept. 9 and harvested Sept. 13 and 14. The fact that any yields were obtained under the circumstances points to the adaptability of this crop. No. 7, an unknown variety, gave 74.7 bushels to the acre. The last twelve varieties named in the table were grown in small quantities in the horticultural section. The yields are all small, but it must be borne in mind that no conclusions regarding the general yield of potatoes can be drawn from them. They are given to indicate the varieties which are apt to do the best under our conditions.

Potatoes.

Variety.	Planted.	Came Up.	Yield.
			<i>Bushels.</i>
1. Early Rose	May 10.	June 25	17.3
2. (Unknown)	"	" 19	37.4
3. Pride of America	"	" 22	11.7
4. Empire State	"	" 25	23.1
5. Mogul	"	" 28	26.6
6. (Unknown)	"	" 28	24.5
7. "	"	" 25	74.7
8. Polaris	"	" 20	11.2
9. Early Minnesota	"	" 28	33.6
10. Early Maine	"	" 2	21.0
11. *Early Ohio	May 16.	" 19	55.8
12. *Pink	"	"	59.4
13. *Beauty of Hebron	"	" 23	11.0
14. *California Rose	"	"	14.9
15. *Smooth Blue	"	" 19	53.1
16. *Clark's No. 1	"	"	59.1
17. *Early Puritan	"	" 22	6.9
18. *White	"	"	43.3
19. *Early Minnesota	"	" 20	19.7
20. *Empire State	"	"	19.5
21. *White Elephant	"	"	27.6
22. *Snow Drop	"	" 27	27.7

*Grown in Horticultural Department.

LANDER.

The effects of the flood, which occurred in 1892, washing the top soil from the Lander Farm, are apparent in the yields of 1893. Much of the ground was foul with weeds, and some crops were plowed under to clear the land. The Red May winter wheat gave the largest yield, 23 bushels per acre. Twelve varieties of potatoes were grown, the larger part giving good yields. The heaviest yield was 314.3 bushels per acre, of Late Puritan. Pride of the West and Vanguard gave the poorest yields. The potatoes were irrigated four times, after the last, Aug. 21, several heavy rains occurred which kept the ground wet and prevented some varieties ripening. The same varieties of potatoes were grown on two different plats, each being treated the same. Plat 2 had the best soil and the yields were much larger than on plat 1. This plainly shows the effects of different soils in the same locality upon the crop, and the value of carefully selecting that most suitable for the crop to be grown.

Flint corn seems to grow and mature better in this locality than the dent varieties, but the grain is much inferior.

Crop Report of Lander Experiment Farm.

Crop.	Variety.	Yield.		Weight per bushel.	Remarks.
Wheat.	Velvet Chaff.	11	bushels	60	Shells out badly.
	Fultz Winter.	12	"	62	Injured by west winds.
	Fulcaster.	10	"	60	Injured by winds.
	Red May.	23	"	62	"
	Early Archangel.	24½	"	46	A fine, plump grain, and very early.
Oats.	Golden Giant.	17½	"	40	A rough looking grain, not desirable for marketing.
	New Black.				Soil very weedy and yield poor; a part only
Barley.	Hullless.	9	"		thresh out for seed.
	Manshury.	20½	"		Soil poor and weedy.
Rye.	Winter.	19 5/7	"	56	No market in this locality.
	Minnesota King.	22 1/9	"		Did not all mature.
Corn.	Dakota Dent.	23 3/7	"		"
	Rideout, or Mercer.	15	"		An early flint variety
Peas.	Cory Sweet.	8	"		Much lost by wind scattering after cutting.
Beans.	Frenchman Field.				Kept too wet in irrigating.
	Boston Pea Field.	188 pounds.			
		Plat 1.	Plat 2.		
		Bushels.	Bushels.		
Potatoes.	Early Rose	221.8			
	Vanguard	109			
	Beauty of Hebron.	161.3		363.8	
	Empire State.	256.2		378.3	
	Late Puritan.	314.3		445.7	
	Early Puritan.	211.7		539	
	Early Mayflower.	251		480.7	
	Bill Nye.	215.3			
	White Elephant.	196.8		466.5	
	Snow Drop.	242.7		425	
	Pride of the West	84		388.7	
	Jumbo.	217.3			
				Were kept too wet by rain after last irrigation.	

SARATOGA.

With the exception of Polish wheat (called Mammoth rye, or Wild Goose rye), which yielded 21 bushels per acre, no farm crops matured sufficiently to obtain yields at Saratoga. Having water for but a small part of the farm, other varieties of wheat, oats, barley and rye were not planted. Seventeen varieties of potatoes were grown as given below and all yielded well. The largest yield was of the Blue Victor, which gave 313 bushels per acre. This is a late potato and a good keeper. The Chas. Downing gave the smallest yield, 148 bushels per acre. The late varieties were injured by the frost. In carrying out the experiments planned, all the varieties will be given further trial. Sorghum and broom corn were frosted Aug. 21, before maturing.

Saratoga.

Crop.	Variety.	Yield per acre.	Weight per bushel.
Wheat.	*Polish.	21 bushels	60 pounds
			Weight of 12 largest.
Potatoes	1. Early Rose.	204 bushels	
	2. Vanguard.	200 "	
	3. Beauty of Hebron.	180 "	
	4. Empire State.	179 "	
	5. Late Puritan.	263 "	8 pounds
	6. Early Mayflower.	294 "	6 "
	7. White Elephant.	245 "	
	8. Snow Drop.	238 "	4 "
	9. Pride of the West.	198 "	
	10. Triumph.	165 "	
	11. Charles Downing.	148 "	
	12. Early Ohio.	198 "	5 "
	13. Clark's No. 1.	243 "	
	14. Early Sunrise.	220 "	
	15. White Russet.	229 "	
	16. Blue Victor.	313 "	8 "
	17. Late Rose.	308 "	10 "

*Not a good flouring wheat.

SHERIDAN.

Saskatchewan Fife wheat produced 31 bushels per acre, which was the largest yield. Winter wheat has not been successful on the Sheridan farm as it winter-kills.

The Wide Awake, Probesterre and Race Horse oats each yielded 50 bushels per acre. The first two weighed 42 pounds per bushel, the last 40 pounds. Barley was quite successful. Rye did poorly. Winter rye is sufficiently hardy to make a good crop.

Each variety of potatoes was not reported separately. The average yield was about 150 bushels per acre. They were planted on poor land and did not produce large tubers nor a large crop.

Sheridan.

Crop.	Variety.	Yield per acre.	Weight per bushel.
Wheat	Polish Wheat	20.8 bushels	56 pounds
	French Imperial	25 "	60 "
	Wellman's Fife	25 "	60 "
	Saskatchewan Fife	31 "	60 "
	Blue Stem	25 "	60 "
	Welcome	45.8 "	40 "
Oats	Wide Awake	50 "	42 "
	Probesterre	50 "	40 "
	Clydesdale	30 "	42 "
	Race Horse	50 "	38 "
	White Russian	41.7 "	40 "
Barley	Vermont Champion	27.1 "	50 "
	Manahury	41.7 "	50 "
	Duck Bill	41.7 "	52 "
	New Black	25 "	58 "
Rye	Spring	20.8 "	52 "
	Winter (Fall)	15 "	58 "
Corn	Squaw	15 "	58 "
	Self-Husking	18 "	.. . . .

SUNDANCE.

No large yields are reported. The largest of wheat was 29 bushels of Whittington. The superintendent states that acclimated seed was used and with wheat it is

far superior to foreign grown. Experiments with oats indicate that early sowing gives better results than where planted late.

This farm is conducted without irrigation and many of the crops were injured by the drouth and hot winds during July. Buckwheat, corn and sorghum were failures. Flax did well considering the season. New Russian yielded $4\frac{1}{2}$ bushels and New Belgian $5\frac{1}{2}$ bushels of seed per acre.

The yield of potatoes is small. Pride of the West, which gave poorer yields at Lander and Saratoga than other varieties, gave the largest yield at Sundance. The experiments with potatoes were conducted to show the relative merits of deep and shallow planting, but no difference was distinguished in the yields or general results.

Sundance.

Crop.	Variety.	Yield per acre.	Weight per bushel.
Wheat	Red Oregon	19 bushels	50 pounds
	Whittington	20 "	50 "
	Saskatchewan Fife	19 "	54 "
	Velvet Chaff Blue Stem	22 "	54 "
	Northcote's Amber	23 "	50 "
	Niagara	16 "	" "
Oats	Clydesdale	10½ "	48 "
	Bonanza	9 "	41 "
	Black Tartarian	15 "	43.5 "
	*Golden Giant Side	13 "	40 "
	*New Welcome	9 "	40 "
	*Early Archangel	16 "	50 "
Barley	New Black	10 "	48.5 "
	Vermont Champion	10 "	48.6 "
	Hulless	6 "	33.6 "
Rye	Northern Spring	6½ "	50 "
	Beauty of Hebron	13 "	
Potatoes	White Elephant	58 "	" "
	Empire State	71 "	" "
	Early Puritan	47 "	" "
	Snow Drop	87½ "	" "
	Pride of the West	43 "	" "
	Early Mayflower	98 "	" "
	Early Ohio	52 "	" "
	Early Rose	65 "	" "
		38 "	" "

*Damaged by drouth.

WHEATLAND.

Although frost came earlier than usual and some crops were injured by rabbits and kangaroo rats, the yields, given in the following table, are better than might be expected.

White Russian wheat gave the largest yield. Winter wheat was not successful and is not recommended for this part of the state as it is apt to winter-kill or be badly injured by early spring winds. Winter rye is more hardy and successful. Experiments were made with oats to test sowing broadcast and harrowing in the seed, versus planting with press drill. One acre was planted in each way with two varieties of oats. The May windstorms destroyed about half the plants in plats sown broadcast while in the drilled plats, only the tops of the plants were injured. They soon outgrew this injury and as will be seen by the table, yielded from one-fourth to one-third more than that sown broadcast. From all his experience at Wheatland, the superintendent recommends deep planting as more successful than shallow.

The non-saccharine sorghums gave good results, Jerusalem corn yielded one ton of fodder without irrigation. As the season was exceedingly dry it proves the ability of this plant to stand drouth. Red Kaffir corn did not mature and the fodder soured after being frosted.

All the varieties of broom corn tried, did well. The California Golden and Evergreen were especially successful, giving good yields of a first-class quality. The dent varieties of field corn have proved better than flint. Minnesota King yielded 43.6 bushels per acre of excellent grain. The experiment with potatoes to test the value of

planting whole or cut tubers is of especial value. Large tubers were used for the cut seed, with two eyes in a piece. Small potatoes were used for the whole seed. Each was given the same cultivation. The whole seed came up much better than the cut, the plants made a much stronger growth and in each of the nineteen varieties the yield was larger. As will be seen by an examination of the table, the difference in the per cent of marketable potatoes was but little, and though generally in favor of cut seed, it is not always the case. In a few instances the per cent fit for market was greater of the whole seed, and in all, the larger yield gave more marketable tubers. While the difference in the two ways might not be so marked in a favorable year, yet the results of this experiment indicate that planting whole seed is the better.

Crop Report of Wheatland Experiment Farm.

Crop.	Variety.	Yield per acre.	Weight per bushel.	Remarks.
Wheat	Velvet Chaff Blue Stem	21.6 bushels	62 pounds	Wind, May 18, injured plants. Quality first-class.
	White Russian	31.6 "	62 "	Wind, March 26-27 killed 75 per cent of plants. Later wind injured tops.
	Fultz Winter	7.8 "	62 "	Wind, May 18, injured tops of plants badly.
Oats.	Saskatchewan Fife	23.2 "	62 "	Badly injured by spring winds.
	May Winter	10 "	64 "	Sown with press drill.
	Early Archangel	32 "	46 "	Sown broadcast and harrowed in.
	"	22.4 "	42 "	Sown with press drill.
	Golden Giant Side	34.4 "	46 "	Sown broadcast and harrowed in.
Barley	Manabury	28.5 "	53 "	35 per cent of plants destroyed.
	Highland Chief	18 "	53 "	Crop entirely destroyed by rabbits.
	New Black	17.3 "	54 "	Crop injured by winds.
Rye	Spring	12.3 "	60 "	25 per cent of plants destroyed by wind.
Buckwheat	Japanese	22.6 "	56 "	
	Silver Hull	20.1 "	54 "	
	Minnesota King	43.6 "	54 "	
Corn	Dakota Dent	36.9 "	74 "	Injured by Kangaroo rats.
	Angel of Midnight	14.5 "	74 "	
	Ridout	19 "	72 "	
	Little Dwarf	16.40 pounds		
Broom Corn	Japanese	640 "		
	California Golden	2176 "		
	Improved Evergreen	2240 "		
	Jerusalem Corn	1920 "		Raised without irrigation.
Fodder Sorghums	Brown Dhoura	5100 "		
	Red Kaffir Corn	3900 "		Did not mature.
	Yellow Milo Maize	6900 "		
	Brothman	7086 "		Grain did not ripen, but fodder of good quality.
Field Peas	Scotchman Field	16.4 bushels	64 "	Injured by wind.
Field Beans	White Field	17.2 "	66 "	Quality first-class.
	Boston Small Pea Field	18.7 "	63 "	

Potatoes—Wheatland Experiment Farm.

Variety.	Yield per acre.	Per cent marketable tubers.	Remarks.
Hoffman	107.7 bushels.	85	Cut seed. 10 per cent failed to grow
"	133 "	80	Whole seed. Good stand
Governor Rusk	126.7 "	80	Cut seed. " "
"	144.4 "	80	Whole seed. " "
Pride of the West	104.2 "	75	Cut seed. " "
"	120.5 "	60	Whole seed. " "
Bill Nye	120.3 "	80	Cut seed. 10 per cent failed to grow
"	136.2 "	70	Whole seed. Good stand
Mammoth Pearl	142.5 "	80	Cut seed. 10 per cent failed to grow
"	180 "	80	Whole seed. Good stand
Late Puritan	83.5 "	80	Cut seed. 25 per cent failed to grow
"	133 "	70	Whole seed. Good stand
Empire State	74.7 "	75	Cut seed. 25 per cent failed to grow
"	149.5 "	75	Whole seed. Good stand
Early Rose	41.2 "	80	Cut seed. 85 per cent failed to grow
"	120.3 "	75	Whole seed. Good stand
Early Ohio	40.5 "	85	Cut seed. 75 per cent failed to grow
"	88.7 "	80	Whole seed. Good stand
Early Puritan	72.9 "	75	Cut seed. 40 per cent failed to grow
"	124.1 "	75	Whole seed. Good stand
Early Mayflower	72.8 "	60	Cut seed. 40 per cent failed to grow
"	120.3 "	75	Whole seed. All grew
White Elephant	126.7 "	80	Cut seed. " "
"	137.6 "	85	Whole seed. " "
New Burbank	107.7 "	75	Cut seed. 20 per cent failed to grow
"	137.3 "	70	Whole seed. 20 " " "
Snow Drop	110.8 "	65	Cut seed. Good stand
"	114 "	50	Whole seed. " "
Vanguard	143.8 "	85	Cut seed. " "
"	158.3 "	85	Whole seed. " "
Beauty of Hebron	77.7 "	75	Cut seed. All grew.
"	104.1 "	60	Whole seed. " "
Jumbo	126.7 "	80	Cut seed. Good stand
"	146.9 "	80	Whole seed. " "
Rose Seedling	104.2 "	80	Cut seed. 25 per cent failed to grow
"	184.9 "	80	Whole seed. Good stand
Triumph	79.2 "	65	Cut seed. 10 per cent failed to grow
"	101.3 "	60	Whole seed. Good stand

Cost and Profit of Growing Wheat.

B. C. BUFFUM.

Experiments were inaugurated in 1893 on each of the Experiment Farms to determine the cost and profit of raising wheat in Wyoming. As the results will vary with the season, condition of soil, price of labor and market price of wheat, the experiment will be repeated the two coming seasons. It may be observed that in the cost of irrigation, only the expense of applying the water to the land is given, omitting the cost of the water. This item will vary with the locality, size of ditch, distance from source of supply and other conditions. But it is believed that the greatest cost would not reduce the profit shown more than 10 or 12 per cent. The cost of producing a single acre is much more in proportion than that of raising larger areas.

M. R. Johnston, of Wheatland, states, "I believe our figures on cost of crop are at the maximum. Irrigating can be done much more cheaply where there is a larger acreage of crops, and harvesting with improved machinery will reduce that item. Our price on labor of \$4.00 per day for man and team is at about the highest limit for common farm labor." One acre was used for each variety in the test, except at Sundance where one-half acre for each variety mentioned in the table, was used. The Sundance Farm being conducted without irrigation, no expense for applying water was incurred. The price in

each instance was the local market price at the time of harvesting. The cost of harvesting at Lander includes cutting and stacking. The reports from Sheridan and Sundance did not include the cost of each item separately. The cost of seed at Wheatland was omitted, but 90 pounds were used, which at one cent per pound would reduce the profit from \$5.68 to \$4.78. In no case was the yield large. The largest was 31½ bushels at Wheatland.

The results compare closely with those obtained on the Nebraska Experiment Farm in 1892 and published in Bulletin 29 of that Station. The average profit per acre obtained at Lincoln for five varieties of wheat is \$8.93, while the average profit obtained in four different parts of Wyoming is \$8.86 per acre in 1893.

Cost and Profit with Wheat.

Place.	Variety.	Yield.	Price per pound.	Value of crop.
Lander	Spring Fife	1440 pounds	1½ cent	\$21.60
Sheridan	Saskatchewan Fife	1860 "	1 "	18.60
Sundance.	Red Oregon	1038 "	1 "	22.38
	Velvet Chaff Blue Stem	1200 "		
Wheatland	White Russian	1898 "	1 "	18.98

Place.	Cost of seed.	Labor putting in crop.	Cost of irrigation.	Cost of harvesting.	Threshing.	Total cost.	Profit.
Lander	\$1.86	\$5.00	\$1.00	\$3.50	\$2.00	\$13.36	\$ 8.24
Sheridan	Cost	of putting	in and	raising	crop.	11.71	6.89
Sundance	"	"	"	"	"	7.75	14.63
Wheatland	"	4.50	4.00	2.00	2.00	13.30	5.68

Sugar Beets in 1893.

E. E. SLOSSON.

Experiments in the culture of sugar beets were carried on at the six Experiment Farms during the past season in much the same manner as in preceding years. In addition to this, small packages of sugar beet seed received late in the spring from the U. S. Department of Agriculture were sent to sixty farmers in all parts of the state with franked tags for forwarding sample beets to Washington for analysis. Of the persons to whom seed was given for experiment, only three reported.

All the analyses of sugar beets published this year were made by the U. S. Department of Agriculture in the chemical laboratory at the World's Fair and at Washington.

The details of cultivation are given below :

CROP EXPERIMENTS IN 1893.

LANDER EXPERIMENT FARM.

J. S. MEYER, SUP'T.

Altitude, 5,500 feet. Soil—See analysis in Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed 8 inches deep, harrowed three times; planted in rows 18 inches apart with garden seeder May 11; 15 pounds seed per acre; sprouted May 20; came

up June 4; thinned June 23; cultivated Aug. 12; irrigated Aug. 23; frosted Sept. 22; harvested Oct. 19.

LARAMIE EXPERIMENT FARM.

F. J. NISWANDER, SUP'T.

Altitude, 7,200 feet. Soil—See analysis in Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed 10 inches deep, harrowed twice, rolled; planted 16 pounds to the acre with hand drill May 9; sprouted June 11; came up June 22; cultivated July 6; irrigated June 21-27, July 6-8; yield, 941 pounds per acre. There was no water in the irrigating ditch until June 21 and weather throughout was very unfavorable.

SARATOGA EXPERIMENT FARM.

J. D. PARKER, SUP'T.

Altitude, 6,749 feet. Soil—See analyses in Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed 7 inches deep, harrowed four times, rolled; planted May 9 with hand drill; sprouted May 18, came up June 5; hoed June 20, July 21; irrigated June 17, July 17, Aug. 20; harvested Oct. 15.

SHERIDAN EXPERIMENT FARM.

J. F. LEWIS, SUP'T.

Altitude, 3,750 feet. Soil—See Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed 6 inches deep, harrowed twice, boarded; planted with hand drill May 8, seed 10 pounds per acre; sprouted May

16, came up May 20; hoed June 12-26, July 7, Aug. 6; irrigated June 27, July 18, Aug. 2; harvested Oct. 30.

SUNDANCE EXPERIMENT FARM.

T. A. DUNN, SUP'T.

Altitude, 4,500 feet. Soil—See analysis in Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed 6 inches deep, harrowed four times; planted May 18 four pounds seeds per acre; sprouted May 24, came up June 1; harvested Oct. 10; not irrigated. Rows were 36 inches apart. The yield would probably have been doubled if the rows had been 18 inches apart as is customary.

WHEATLAND EXPERIMENT FARM.

M. R. JOHNSTON, SUP'T.

Altitude, 4,700 feet. Soil—See analyses in Bulletin No. 6. Weather—See this Bulletin, page 36. Cultivation—Plowed twelve inches deep, harrowed six times, rolled; planted May 4 in drills 16 inches apart, 20 pounds seed per acre; sprouted May 16, came up May 22; cultivated four times with plow and hoe; irrigated June 17, 26, July 8, 9, 21, Aug. 8, 28; frosted Sept. 20; harvested Oct. 9.

JOHN ASTLE, AFTON, UINTA COUNTY.

Soil, brown loam. Weather—May cold, June mild, August hot and dry with cold nights, September cold and dry, October 1, snow and rain. Cultivation—Planted May 20; irrigated four times; harvested Oct. 1.

ALFRED BRIDGER, SYBILLE, LARAMIE COUNTY.

Soil, sandy loam. Weather, warm, but very changeable. Planted June 2, harvested Oct. 12.

MARK MANLEY, MOUNTAIN VIEW, UINTA COUNTY.

Soil, sandy loam, second year of cultivation. Weather—May wet, June dry, July hot and dry, August showers, September dry to 15th then heavy rains and snows. Nights very cool all summer. Cultivation—Planted May 10, irrigated four times, harvested Oct. 2.

SUMMARY.

The results of the experiments in the cultivation of sugar beets in Wyoming are as follows:

Season.	Per cent Sugar in juice.	Purity.
1891.....	15.79.....	78.08
1892.....	16.69.....	78.69
1893.....	17.07.....	80.91
Average	16.52.....	79.23

Analyses of Wyoming Sugar Beets, 1893.

Grown by	Variety	Crop tons per acre.	Average Weight.		Sugar.		Purity
			Ounces.	Grams.	Per cent in juice.	Per cent in beets.	
Experiment Farm, Lander, Fremont County	Improved Bulteau.	25.5	28.5	810	15.8	15.0	83.1
" " " " " "	" " "	25.5	23.5	657	15.7	14.9	85.4
" " " " " "	Klein Wanzenleben	24.0	14.3	406	15.9	15.1	75.7
" " " " " "	Knauer Imperial.	21.0	17.0	481	16.4	15.6	80.9
" " " " " "	Vilmorin Richest.	20.5	18.6	527	16.2	15.4	77.4
Laramie, Albany County	Klein Wanzenleben				13.2	12.5	73.9
" " " " " "	Knauer Imperial.				12.9	12.3	73.9
" " " " " "	Vilmorin Richest.				13.8	13.1	78.8
" " " " " "	Klein Wanzenleben.	16.3	47.0	1350	16.7	15.9	84.8
" " " " " "	Vilmorin Richest.	16.3	47.5	1344	16.8	16.0	81.5
" " " " " "	" " "	16.3	10.9	310	15.8	15.0	85.0
" " " " " "	Improved Bulteau	13.6	17.7	500	22.5	21.4	86.1
" " " " " "	" " "	13.6	12.2	347	17.7	16.8	83.9
" " " " " "	Klein Wanzenleben	17.0			21.0	20.0	82.7
" " " " " "	" " "	17.0			17.7	16.8	78.9
" " " " " "	Improved Bulteau.	10.5	16.0	453	17.5	16.6	84.1
" " " " " "	" " "	3.3			18.0	17.2	80.3
" " " " " "	Klein Wanzenleben	3.1			14.1	13.4	72.3
" " " " " "	" " "	3.0			18.0	17.1	76.0
" " " " " "	" " "	3.0	13.8	389	16.2	15.4	76.0
" " " " " "	" " "	3.0	13.5	382	14.5	13.6	73.7
" " " " " "	Vilmorin Richest.	3.8			15.7	14.9	72.0
" " " " " "	" " "	3.8	10.5	297	17.8	16.9	87.8
" " " " " "	Knauer Imperial.	6.8			17.8	16.9	85.1
" " " " " "	Vilmorin Richest.	6.2			18.9	17.7	80.9
" " " " " "	" " "	6.2	8.5	239	22.7	21.6	80.1
" " " " " "	Klein Wanzenleben	6.2	10.3	283	22.3	21.2	80.4
" " " " " "	Improved Bulteau	6.8	9.3	263	22.0	21.8	79.1
" " " " " "	Klein Wanzenleben	6.0	20.7	575	13.0	12.4	70.4
" " " " " "	Vilmorin Richest.		20.7	575	16.0	15.6	73.1
" " " " " "	Improved Bulteau.		21.0	595	13.6	12.9	81.5
Mark Manley, Mountain View, Uinta County	" " "						
Alfred Bridger, Sylville, Laramie County	" " "						
John Astle, Alton, Uinta County	" " "						
Average					17.07	16.23	80.91

Experience in these diverse seasons shows that beets unusually rich in sugar can be grown by irrigation in almost all parts of Wyoming. In every crop reported, the per cent of sugar has been above twelve, the lowest marketable rate. From the increase in sugar content and in coefficient of purity we may expect an improvement in the quality of the beets when the land has been longer under cultivation and the growers have acquired more experience. The prices paid at the factories in Nebraska are \$5.00 per ton for beets containing 16 per cent sugar and \$5.50 for beets containing 17 per cent sugar.

In regard to the yield the results are not as conclusive. In some cases the reported yield is remarkably high, in others altogether too low for profit. In the localities represented by the Experiment Farms at Lander, Saratoga, Sheridan and Wheatland a yield of ten to fifteen tons per acre can be expected under irrigation and proper cultivation.

In ascertaining and publishing the facts concerning the prospects of Wyoming in this new field of agriculture the work of the Experiment Station is completed. It now remains for the people of Wyoming to decide upon the data which have been furnished whether the establishment of sugar factories in the state will be profitable. The Station will, however, furnish any available information on the subject of the culture of beets and the manufacture of sugar to those contemplating the establishment of this industry. Sugar beets will be grown upon the Experiment farms for some years to come to ascertain the effect of the climate, and to test home grown seed, but it is not probable that seed will be distributed free for experimental purposes as heretofore. We shall, however,

be glad to receive the names of any farmers who are willing to experiment in this or other lines. Bulletin No. 3, giving directions for the cultivation of sugar beets, and Bulletin No. 9, giving the results of the crop experiments in 1892, will be sent on application.

The U. S. Department of Agriculture has for several years carried on experiments in sugar beets in all parts of the country, and the following extract from the last report of the Secretary of Agriculture, gives the results of the work in the Arid Region :

"Beets which have been grown upon irrigated land in Wyoming, Idaho, Colorado and New Mexico are uniformly of high character and rich in sugar. It is evident that there is perhaps no crop which can be so successfully cultivated upon irrigated land as sugar beets. The cost of irrigated land makes it necessary that some crop should be grown which will yield a large return. Land which has cost from \$50 to \$100 per acre to irrigate cannot be seeded with financial success to such crops as will yield a net profit of only \$4.00 to \$5.00 per acre. Such land should be made to yield at least a net profit of from \$10.00 to \$15.00 per acre in order to pay proper interest on first cost of the soil. There is no crop yet which has been introduced into the arid regions which gives such promise of producing the above result as the sugar beet. The market for sugar cannot be overstocked, hence there is no danger of blocking the market in case all the lands which have been recovered by irrigation should be planted in beets. It would be quite different if they were planted with potatoes or some similar crop, whose overproduction might glut the market. It is no wonder that capitalists

are looking with interest to this new opening for investment.

“Climatic conditions, as has already been stated in previous publications of the Department relating to sugar beets, are of the utmost importance not only in the growing of the crop, but in the harvesting thereof. In the irrigated lands of our arid regions we have a complete control of climatic conditions. In the first place there is during the growing season, almost unbroken sunshine, a condition essentially favorable to the production and storage of large quantities of sugar. In the second place, the high altitude of the plateaus of the arid regions gives a summer which is not too warm for the proper growth of sugar beets. In the third place, the control of the water for irrigating purposes renders it possible to stimulate the growth of beets during the earlier periods of the summer, while the withdrawal of the water prevents any second growth after the beets have matured in the autumn. In the fourth place, the dry autumnal weather is most favorable to harvesting the crop, and the period of frosts is so well known as to permit of the entire harvest being made before any danger of freezing occurs. It is believed that in no other place in the world can be found such a favorable agreement of climatic conditions for the production of not only large crops of beets per acre, but also of beets rich in sugar of high purity.”—*Report of the Secretary of Agriculture, 1892, page 135.*

It will be observed that the expenses here given are too high for Wyoming, as at present good land can yet be obtained at from \$10 to \$20 per acre, with water right in perpetuity, and the cost of irrigating sugar beets is not more than \$1.50 or \$2.00 per acre for the season where a number of acres are grown.

Garden Vegetables and Tobacco.

B. C. BUFFUM.

It may be stated in general, that those varieties which were sufficiently early, of good quality and yielded well upon any of the Experiment Farms may be recommended for that part of the state. At Saratoga no yields were given, but some notes were furnished which may be of value. No report of garden vegetables was obtained from Lander. At Sheridan experiments with vegetables were of little or no value. One variety of sweet corn, the Golden Dew Drop, matured seed, yielding 16 bushels per acre. A quantity of water melons were marketed, the varieties which ripened being Cuban Queen, Ironclad, Lewis' Early and Peerless.

Yields at Sundance and Wheatland were good, especially with root crops, including sweet potatoes at the latter place. Experiments with peanuts at Wheatland in 1892 were quite satisfactory, but the crop of 1893 was destroyed by rabbits. At Sundance the peanuts did not germinate.

Tobacco has been successfully grown at Wheatland for two seasons. The notes for the past season are given under a separate head.

GARDEN VEGETABLES.

LARAMIE.

Asparagus.—Two dozen roots set in bed in 1892

came up well. Nineteen lived through the winter and grew nicely the past season.

Beans.—Seventeen varieties were planted. Only wax varieties grown for string beans are recommended for this altitude. Owing to the dry condition of the soil, all varieties were slow in germinating, which made it late in the season before they were ready for market. The earliest varieties were Early Longfellow Six Weeks and Dwarf Horticultural, which were marketed Aug. 8. Early Lima, Early Warwick, Early Mazagan and Golden Refugee were ready for market Aug. 16.

Cabbage.—The varieties planted were Red Erfort, Red Dutch, Prime Flat Dutch, Lee's Wonderful and Early Jersey Wakefield. All matured heads and can be grown with great success.

Cauliflower.—Early Dwarf matures and produces a good crop.

Lettuce.—Those varieties which were ready for market earliest were Early Boston, Curled, Early Curled Simpson and Black Seeded Simpson.

Peas.—Thirty-eight varieties were grown. Though not so early as several others, the Pride of the Market was the most prolific. White Marrowfat was the earliest variety last season and the Stratagem the latest marketed. Telephone and Everbearing proved good varieties.

Beets.—Twelve varieties were grown. The Improved Blood was most prolific, yielding over 6,000 pounds per acre. Eclipse yielded 5,382 pounds, and Extra Early Dark Flat Egypt, 3,848 pounds. Bunches of Early Blood were marketed on Aug. 6.

Radish.—Chartiers Long Scarlet is one of the earliest, most prolific and hardy. Other varieties are French

Breakfast, White Tipped Turnip, Early Round Dark Red. The two last named are more apt to become pithy than Chartiers.

Turnips.—Seven varieties were grown. All were badly damaged by the turnip flea beetle. They were ready for market Aug. 31, and yielded as follows: Early White Egg, an early sweet table variety, 1,025 pounds; Long White Cow Horn, 1,599 pounds; White Stone, 1,189 pounds; Early Purple Top Milan, 1,968 pounds; Robert's Golden Ball, 1,845 pounds; Early White Dutch, 2,685½ pounds; Pomerian White Globe, 5,248 pounds. All are good table varieties.

SARATOGA.

Beans.—Earliest varieties were Extra Early Refugee and Early Warwick. Only wax varieties to be used as string beans can be recommended.

Cabbage—Early York and Winningstadt matured good heads. The late varieties failed to mature on account of drouth.

Cauliflower.—Henderson's Early Snowball gave best results, maturing good heads.

Lettuce.—Boston Market, Black Seeded Simpson and Golden Queen were earliest, being ready for market June 25.

Peas.—Henderson's First of All, Bliss Abundance, Summit, Fill Basket and Champion of England were the earliest varieties and all were very prolific. No yields are given, but the superintendent states that all were successful and especially recommends the above.

Squash.—Winter varieties did not ripen. Crook

Neck and Early Bush summer grew well and produced good table squashes.

Tomatoes.—A few, supposably of the Dwarf Champion, ripened.

SUNDANCE.

Beans.—The earliest were ripe Sept. 1, and yielded as follows: White Wax, 142 pounds per acre; Black Wax, 160 pounds; Navy, 240 pounds; Flageolet Wax, 170 pounds. The last named were ready for table first.

Sweet Corn.—The Mammoth produced roasting ears by August 17, but the crop did not mature and was pronounced a failure.

Peas.—The following varieties with yields are reported: Alpha, 726 pounds per acre; Early Kent, 726 pounds per acre; Champion of England 660 pounds; Stratagem, 640 pounds; Tom Thumb, 655 pounds. All are good varieties.

Beets.—Varieties and yields were: Early Blood, 10,856 pounds per acre; Early Bassano, 11,061 pounds per acre; Early Eclipse, 11,334 pounds; Extra Early Dark Egyptian, 8,840 pounds; Improved Dwarf Dark Blood, 8,893 pounds; Improved Long Blood, 8,316 pounds; Dewing's Early Turnip, 12,512 pounds.

Carrots.—Early Scarlet Horn yielded 7,386 pounds per acre; Early Half Long Stump Rooted, 7,525 pounds; Early Half Long Carenthrall 5,123 pounds; Early French Forcing, 4,420 pounds. The half long varieties are considered best.

Parsnips.—Long Neck Sugar yielded 2,727 pounds per acre and Gurnsey Hollow Crown, 2,448 pounds.

Turnips.—White Stone yielded 14,014 pounds; Rob-

erts' Golden Ball, 16,774 pounds. Both are excellent varieties.

Salsify.—Gave a yield of 4,590 pounds per acre.

WHEATLAND.

Beans.—Only one variety was grown, the Boston Small Pea Bean, which yielded 1,120 pounds on an acre and weighed 63 pounds per bushel. The market price was three cents per pound, making the value of the crop \$33.60. The estimated cost of producing the crop was \$15.25 leaving a profit of \$18.35 per acre. This is a fine variety, the vines being strong and thrifty, the beans well formed, of uniform size and excellent quality.

Sweet Corn.—New Honey was ready for market Aug. 20 and yielded 800 pounds of seed. Cory, the earliest and most prolific variety grown, was ready for market Aug. 1, and produced 1,600 pounds of seed. Marble-head was ready for market Aug. 12, but did not mature its seed.

Beets.—Wind storms of May 18 and 19 destroyed from 10 to 20 per cent of the young plants of each variety. The Improved Long Blood gave a yield of 43,776 pounds per acre; a good stock beet. Dark Egyptian produced 13,760 pounds; a good quality for table use or stock. Improved Dwarf Blood, yield 12,800 pounds; good for table use. Early Blood Turnip, yield 14,400 pounds; good for either table or stock. Early Eclipse, yield 14,016 pounds; good quality. Early Blood Turnip and Improved Dwarf Blood were the earliest varieties, but the last did not seem as hardy as the others, as the wind destroyed more of its plants.

Carrots.—Wind destroyed many of the young plants.

As much as half the Early French Forcing were killed. All varieties were of good quality, Half Long Scarlet Courtney and Early Scarlet Horn being the earliest. Early French Forcing produced 9,600 pounds per acre, Early Scarlet Horn, 15,664 pounds; Half Long Stump Rooted, 39,808 pounds, and Half Long Scarlet Courtney 24,640 pounds.

Parsnips.—These were also injured by the wind. Gurnsey or Hollow Crown produced 9,856 pounds of only fair quality; Long Smooth Sugar, 6,272 pounds of good quality.

Sweet Potatoes.—Early Golden, ripe Sept. 20, yield 5,475 pounds; good quality and 75 per cent fit for market. Extra Early Carolina were ripe Sept. 10, yield 6,132 pounds; 80 per cent fit for market; of first-class quality, Red Bermuda, ripe Sept. 20, yield 7,300 pounds; 80 per cent fit for market; the heaviest yielder but of poor quality.

TOBACCO.

A small amount of tobacco was grown in 1892, and did so well that it was given a further trial the past season. Each of the varieties planted grew well and fully matured in good season, being harvested Sept. 9 to 12. A heavy wind storm on Sept. 1 injured all the varieties somewhat. As the weather was so dry after harvesting, the crop could not be stripped so yields cannot be given at this time. The following notes upon each variety indicate that tobacco can be grown with profit, and it is hoped more complete data will be obtained the following season to show the degree of success with which it can be raised extensively :

Pennsylvania Seed Leaf.—Twenty-four plants were set out June 2. All lived and were mature Sept. 12. They grew to a good height and produced large leaves.

Connecticut Seed Leaf.—Twenty-four plants set out June 2. All grew to a good height, producing medium sized leaves. It was mature Sept. 12.

Harby.—Twenty-four plants set out June 2, two of which died. The rest grew to a height of four feet, producing large leaves and were mature Sept. 12.

Persian.—Of the twenty-four plants set out June 2, eight died. The plants grew only two feet high and produced small leaves; were mature Sept. 10.

Comestock Spanish.—Twenty-four plants set out June 2. All lived, grew about three feet high and produced medium sized leaves; matured Sept. 10.

Progress Report upon Fruits and Trees.

B. C. BUFFUM.

As this was only the second season from planting, the fruits have not progressed far enough to merit a detailed report of varieties. Only general statements are made about each kind with notes upon hardiness, varieties which have fruited, and necessary winter protection. From the results already obtained, there is little doubt that Wyoming can raise sufficient quantities of the small fruits at least, to supply the home demand. Compared with the profit of raising wheat, of from five to fifteen dollars per acre, it is safe to say that with even lower prices than existing ones, raising fruit near our markets will yield a net profit ten times as great. Our conditions are as favorable as those in adjoining states where fruit raising has advanced rapidly in the last few years. The few farmers who have grown small fruits and the results obtained upon the Experiment Farms sufficiently demonstrate that such fruits will grow successfully, and our future bulletins upon this subject will discuss special topics.

SMALL FRUITS.

Strawberries.—Fifty varieties were planted in 1892, the same ones being ordered for each farm, from growers

in New York, New Jersey and Colorado. From the reports at hand there is no apparent difference in the hardiness and vitality of the plants from our eastern and western growers. Those obtained from Peter Henderson & Co., were pot grown plants. They were large and looked thrifty when they arrived, but having been grown indoors, they were so tender that a large per cent of them died when set out. None survived through the summer at Laramie and few or none lived of many of the varieties upon the other farms. Strawberries require some winter protection. A thorough covering of straw or loose mulch, held down by poles or other weights to keep the wind from blowing it off, is generally sufficient, though where only small areas are grown, earth covering is recommended. At Laramie a covering of earth deep enough to keep the plants from dying out is absolutely necessary to make them live. All the plants upon the Laramie Farm not so covered died the first winter.

At Lander eighteen varieties fruited well, of which the Mammoth is reported as producing the largest berries of fine flavor.

On the Sheridan Farm the superintendent states that Michel's Early, Crescent, Manchester, Lady Rusk, Cumberland, Bubach's No. 5, Gandy and Eureka were the best, being most hardy, prolific and of good flavor.

At Saratoga Edgar Gem, Capt. Jack, Iowa Beauty and Shuster's Gem are mentioned as of best quality and the most productive this season.

Raspberries and Blackberries.—Those varieties which were in good condition when set out made thrifty growth. The cause of failure to live of many plants at Lander,

Saratoga, Sheridan and Sundance was due to the delay in the plants reaching them and their consequent poor condition when set out. Some were on the road over a month and many of the plants were dead or past reviving when received. A few fruited this season. It is necessary to cover with earth for winter protection and deep enough to keep the canes moist. All the raspberries set out upon the Laramie Farm died the first winter. A small per cent of the blackberries lived.

Grapes.—Have not done well at Laramie and Sundance, though the causes of failure are not apparent. In general the same causes produced failure, and the same winter protection is necessary as with raspberries. Except upon the above mentioned farms they are growing well.

Currants and Gooseberries.—Are sufficiently hardy for any part of the state. On the Laramie Farm the most hardy varieties tried are Black Naples, Crandall, Fay's Prolific and White Grape currants and Smith's gooseberry. At Saratoga White Grape currant bore heavily, the bushes bending nearly to the ground with fruit. The only winter protection necessary is a mulch around the roots.

LARGE FRUITS.

Apples, plums and cherries are thriving at all the farms. The crab trees have made the largest growth at all the farms and the hardy varieties of standard apples set out have lived and grown especially well at the Lander, Sundance and Wheatland Farms. At Lander English Morello and Early Richmond cherries each bore and ripened a small quantity of fruit.

At Saratoga Dakota plum trees made a good growth and bore a few plums though they did not ripen on account of the early frost.

The pears set out which lived through the first season as a rule have thrived. Apricots have not been quite so successful, though some trees of all varieties lived at Wheatland, and all but the Russian at Lander. The Gibb apricot at the latter place made the largest growth of any tree planted. This variety has done well at the other farms and seems to be very hardy. Except at Wheatland, quinces have not appeared to be sufficiently hardy.

Native plums, buffalo berries, june berries, raspberries and strawberries have been transplanted to the Experiment Farms. We have not succeeded in making the buffalo berries, strawberries or raspberries grow on the Laramie Farm. Lack of water and their exposed position is probably the reason, as all our natives are acclimated and hardy.

FOREST TREES.

Cottonwoods and Russian Willows have been set out on each of the farms for windbreaks. The Russian willow cuttings have made thrifty growth and seem perfectly hardy. At Laramie all those which started the first season made good growth and are alive to the tips at the present writing. Complaint has been made that they produce too many small whip like stems instead of growing at once into trees. After two or three years' growth they usually stop spreading from the root and grow more upright.

The growth of Honey Locusts set out at Laramie in

1891 for hedge has been exceedingly slow. A large per cent of the trees are still alive but only a few short branches have been put forth.

Ash and Elm seedlings have thrived well, though at our high altitude their growth is slow. The White Ash seedlings seem hardy and at Lander are highly spoken of as making stocky little trees.

Notes on Climate.

B. C. BUFFUM.

During the year of 1893 the climate has been exceptional in many respects and unfavorable to the growth of crops.

For the greater part of the state the temperature was lower than in 1892. At Laramie the means varied but little from that of the two preceding years, but the months of March, April, May, September and November were colder than the same months in 1892, while the months of June, July and August were warmer and drier. This shortened the growing season and caused the warm months to be more unfavorable than in the preceding year. In general the same difference in temperature between this and previous years prevailed at all the Experiment Farms, September being notably colder at each. Killing frosts occurred earlier in nearly all parts of the state than in 1892. There were no heavy storms of snow or rain during the year, consequently the amount of precipitation was unusually small. A letter from E. M. Ravenscraft, Director of the State Weather Service, states: "The rainfall for 1893 was below the normal throughout the entire eastern portion of the state and the absence of heavy storms was remarkable." He kindly furnished the data for Cheyenne, which is given in the table of precipi-

tation. The normal for Cheyenne is about 12.50 inches. The greatest precipitation during one day occurred at Sundance in May, when 2.18 inches of rain fell. At Laramie the greatest amount during any single storm was 0.47 inches in June and August. At Lander 1.01 inches in June. At Saratoga 1.20 inches in May. At Sheridan 1.70 inches in May. At Wheatland 0.60 inches in October and December. Saratoga was the only Station having a greater amount of precipitation than in 1892. There was an unusual amount of rain in August and several quite heavy snow storms occurred in the Platte Valley during the year. The precipitation at Laramie was less than ever before recorded at this place, being only 3.84 inches. The Report of Rainfall in the Western Territories, issued by the Department in 1888, states that records of precipitation were kept by the U. S. Post Hospital at Fort Sanders, three miles south of Laramie, covering a period of nine years and five months from Feb. 1869 to Aug. 1878. During this time the normal was 12.92 inches. The greatest amount during any one year was 17.77 inches in 1872. The least occurred in 1871, when only 8.16 inches fell. The least annual precipitation which has been observed in the state is 2.38 inches at Fort Laramie in 1860.

The small amount of rainfall at Laramie in 1893 seems to be due to the fact that the storms precipitated the larger part of their moisture on the mountain ranges east and west of the Laramie plains, causing only traces or small amounts at Laramie. At the Experiment Farm, nearly three miles west of the University, the rainfall for the growing months was much heavier than at the University. The rainfall at the farm for May was 2.00 inches,

June 1.16, July 0.94, August 1.10. Several quite heavy rains occurred which only gave a trace in town. At Wheatland the rainfall was less than half, and at other stations, except Saratoga, much less than that of the previous year.

Hail storms occurred on the 28th and 29th of June, near Sheridan, destroying tender vegetation in a path about one mile wide.

The number of stormy days during which .01 or more rain fell are as follows : Laramie 44, Lander 38, Saratoga 50, Sheridan 46, Sundance 51, and Wheatland 20. The greatest number in one month was 11 at Saratoga in May. None occurred in Laramie in January.

The mean relative humidity or per cent of moisture in the air was much lower than the previous year, being 63.7 in 1892 and 56.9 in 1893. June was the driest month with only 38.3 and July and September were nearly as dry. The mean dew point for the year was correspondingly low.

There was over 10,000 miles more of wind than in 1892.

EVAPORATION AT LARAMIE.

Evaporation from water surface is measured by means of a Hook Gauge, measurements being taken every day that the water is not frozen. A tank of galvanized iron holding one cubic meter of water is used. Care is taken to keep the tank nearly full that evaporation may not be interfered with. Evaporation cannot be obtained as accurately for the winter months as during the remainder of the year. It was, apparently, 46.305 inches from Oct. 1, 1892 to Oct. 1, 1893. For six months, May to

October inclusive, it was 37.525 inches. During the time the water was not frozen, it was as follows:

April 24-30.....	0.562 inches.
May.....	4.801 "
June.....	7.884 "
July.....	9.352 "
August.....	6.586 "
September.....	6.016 "
October 1-31.....	2.886 "

EXPLANATION OF TABLES.

TEMPERATURE.—The mean temperature at the Experiment Farms is taken from the maximum and minimum readings. At Bates' Park (Freeland) the observations are taken by Mrs. C. M. Cheney three times daily, at 7 a. m., 2 p. m. and 9 p. m. and the mean for each day is found by the formula $\frac{7+2+9}{3}$.

At Inyan Kara the observations are taken by S. A. Young twice daily and the mean is obtained by the sum of both readings divided by 2, which probably gives results too high for summer months, but nearly as close to the actual mean in the cold months as that from the maximum and minimum readings, since during these months the minimum temperature usually occurs near 7 o'clock a. m. and the maximum between 2 and 3 o'clock p. m. The daily range of temperature is the difference between the maximum and minimum readings.

In Table IV. the records of the barometer are not complete, as the instrument was out of order for nearly four months and consequently the annual mean is not correct.

In the same table, also, the amount of wind is given

only for each month, with the greatest velocity for the month. For further data on the wind see General Summary.

The precipitation at each Experiment Farm, given in Table V., is observed by the superintendent. The record for Cheyenne was furnished by the Chief of the State Weather Service, for Bates' Park (Freeland) by Mrs. C. M. Cheney, for Trelona by James Jackson, for Inyan Kara by S. A. Young, for Hat Creek by Andrew Falconer and for Sybille by A. E. Bridger. Thanks are due each of these observers for the interest taken and time spent in furnishing the records. We hope others will volunteer to furnish records of rainfall. Observations at high altitudes in the mountains would be of special value.

TABLE NO. I.
Temperature, 1893.

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.....	26.8	20.7	26.8	34.2	44.2	57.2	64.0	60.7	52.8	42.3	29.2	21.6	40.6
Lander.....	29.3	21.5	29.2	36.4	50.0	62.2	69.6	66.2	57.5	44.9	34.3	30.3	44.3
Saratoga.....	22.1	17.6	26.8	34.5	45.0	56.3	64.1	60.9	49.9†	41.0	26.9	24.8	30.3
Sheridan.....	23.6	12.9	21.5*	38.6	51.9	61.3	69.2	65.4	57.8	44.3	27.2	23.6	40.7
Sundance.....	19.7	14.6	21.5†	35.2	48.6	62.1	69.0	66.1	57.6	41.7	27.6	23.8	40.6
Wheatland.....	33.1	23.0	36.7	41.0	53.0	67.3	74.1	69.6	62.4	49.3	37.6	32.5	48.8
Freeland (Bates' Park).....	20.2	24.0	31.4	37.4	47.3	64.5	73.1	67.8	60.8	45.4	31.9	29.7	44.5
Inyan Kara.....	21.1	20.2	25.8	35.9	51.7	71.2	76.0	69.0	.....	.....	.....	.....	.....

*First 21 days of month.

†8 a. m. and 8 p. m.

‡First 10 days of month missing.

TABLE II.
Daily Range of Temperature.

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.....	22.0	21.1	20.6	21.7	25.9	32.8	30.8	28.0	23.1	24.4	22.5	16.8	25.0
Lander.....	24.1	24.0	23.6	21.5	24.6	32.8	27.6	27.1	25.2	25.2	22.9	20.7	24.7
Saratoga.....	19.6	22.9	21.9	21.3	25.4	32.3	34.4	32.4	27.3†	26.4	22.1	22.0	27.1
Sheridan.....	22.8	26.2	24.5*	23.6	25.3	30.4	27.6	27.8	26.2	26.1	23.3	22.7	28.5
Sundance.....	19.3	23.1	22.1	20.0	24.1	27.0	29.6	26.7	23.5	24.5	24.3	21.4	24.6
Wheatland.....	26.3	26.3	27.7	28.3	31.7	34.8	34.6	34.9	37.1	33.1	29.8	25.5	30.9

*First 21 days. ‡First 10 days missing.

TABLE III.—*Weekly Means of Soil Temperatures, Laramie, 1893.*

Week ending—	Air Tem- perature.	3 inches.	6 inches.	12 inches.	24 inches.	36 inches.	72 inches.
January 7	32.8	28.5	29.1	29.6	31.3	33.3	39.2
January 14	25.1	24.6	27.0	29.0	31.4	33.1	34.5
January 21	16.3	17.3	21.1	24.4	28.6	32.0	37.8
January 28	32.4	28.0	28.5	28.4	29.1	31.0	37.2
February 4	22.9	23.4	25.5	27.7	29.4	31.3	35.6
February 11	21.9	23.0	25.7	27.3	28.8	30.9	36.3
February 18	19.7	21.4	24.5	26.1	27.9	30.2	35.8
February 25	24.4	24.2	26.6	27.8	28.8	30.3	35.5
March 4	17.3	21.8	24.3	25.8	27.4	29.6	35.1
March 11	29.2	28.4	29.6	29.4	29.4	30.2	34.9
March 18	23.5	27.4	29.5	29.7	30.2	30.9	34.7
March 25	27.9	29.5	31.4	31.1	30.8	31.2	34.7
April 1	30.1	35.9	35.3	32.1	31.4	31.6	34.9
April 8	41.0	39.9	40.5	37.2	32.7	31.9	35.0
April 15	27.7	31.9	34.2	34.1	33.6	33.4	35.1
April 22	31.6	34.6	36.5	35.5	34.6	34.4	35.6
April 29	37.5	38.7	41.1	41.2	38.4	37.1	36.4
May 6	33.8	37.8	40.5	40.4	39.6	38.9	37.6
May 13	45.1	46.9	47.7	45.6	42.1	40.6	38.8
May 20	53.7	55.2	56.2	54.2	49.2	46.5	40.8
May 27	40.4	46.9	48.4	49.2	48.4	47.5	43.0
June 3	46.5	52.5	53.1	51.8	48.9	47.7	44.1
June 10	52.5	54.2	55.0	53.4	50.2	48.9	45.1
June 17	61.5	65.1	65.3	62.6	56.8	54.1	46.8
June 24	60.5	68.0	68.6	66.2	60.7	57.9	49.3
July 1	59.3	68.6	67.6	65.9	61.8	59.5	51.4
July 8	65.2	70.7	71.0	69.0	63.7	61.1	53.1
July 15	63.7	68.8	70.5	68.8	65.0	62.6	54.6
July 22	64.8	72.1	73.5	70.3	65.5	63.0	55.8
July 29	63.8	67.9	70.6	69.6	66.4	64.2	56.8
August 5	62.2	67.0	69.7	67.9	65.0	63.2	57.3
August 12	62.8	66.1	69.2	67.7	64.9	63.3	57.6
August 19	61.3	63.0	66.5	65.8	63.6	62.4	57.7
August 26	60.4	64.9	67.4	66.3	63.6	62.1	57.5
September 2	54.9	60.0	62.7	62.0	61.9	61.2	57.4
September 9	58.6	60.2	65.3	63.2	61.3	60.3	57.1
September 16	55.0	60.9	63.4	62.4	60.7	59.9	56.8
September 23	51.2	55.7	59.5	59.4	59.1	58.8	56.4
September 30	45.9	51.2	56.5	56.1	56.5	56.6	55.8
October 7	38.8	39.4	43.3	46.3	51.1	52.8	54.6
October 14	44.0	42.9	46.0	47.5	49.2	50.3	52.9
October 21	45.7	43.3	46.0	46.3	47.6	48.6	51.6
October 28	39.7	40.5	42.3	43.9	46.5	47.7	50.4
November 4	38.7	40.3	42.1	42.9	44.9	46.0	49.4
November 11	35.2	36.8	38.8	40.3	43.0	44.4	48.3
November 18	25.8	31.0	33.3	35.4	39.9	41.9	47.0
November 25	20.9	26.3	28.3	31.0	36.4	39.0	45.4
December 2	32.8	31.5	42.2	32.9	35.6	37.5	44.0
December 9	23.8	24.4	30.5	32.6	36.2	37.8	43.0
December 16	31.2	28.9	29.9	31.7	35.1	36.9	42.3
December 23	32.3	29.1	29.6	30.3	33.7	35.6	41.5
December 30	18.6	23.5	26.0	29.1	33.1	34.7	40.6
Sums	2120.9	2242.1	2355.9	2345.3	2331.0	2335.9	2355.1
Annual Means	40.8	43.1	45.3	45.1	44.8	45.0	45.3

Laramie, 1893.

Month.	Relative Humidity.			Dew Point.			Barometer.			Wind.			Terrestrial Radiation.	
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Greatest Velocity.	Miles.	Direction.	Highest.	Mean.
January.....	91.8	9.2	56.0	39.3	-16.0	5.8	23.307	22.501	22.970	50	11897.7	W	7.7	3.7
February.....	100	32.0	70.7	21.4	-8.5	7.8	23.248	22.867*	22.867*	48	12873.3	W	5.8	3.3
March.....	100	32.8	67.7	30.5	-0.5	14.9	23.248	22.561*	22.867*	46	12829.0	W	5.6	3.7
April.....	100	22.4	62.2	34.5	4.7	18.0	23.248	22.561*	22.867*	46	12829.0	SW	6.7	2.3
May.....	100	10.7	54.7	38.1	12.0	26.0	23.248	22.561*	22.867*	68	12829.0	W	5.5	2.0
June.....	85.2	10.9	38.3	50.3	13.5	30.9	23.248	22.561*	22.867*	68	12829.0	SW	10.2	4.2
July.....	81.3	10.5	43.9	54.5	13.3	38.8	23.248	22.561*	22.867*	50	12829.0	SW	8.3	4.1
August.....	80.9	11.2	43.9	52.6	10.6	44.7	23.248	22.561*	22.867*	60	12829.0	SW	11.0	4.6
September.....	92.8	11.2	43.9	52.6	10.6	37.1	23.248	22.561*	22.867*	48	12829.0	SW	7.2	3.0
October.....	100	30.0	57.2	30.4	10.5	22.2	23.248	22.561*	22.867*	58	12829.0	SW	7.5	3.8
November.....	100	30.0	60.0	28.8	-10.5	13.5	23.248	22.561*	22.867*	48	12829.0	W	6.8	3.6
December.....	100	38.3	70.9	30.1	4.3	14.9	23.248	22.561*	22.867*	48	12829.0	W	6.8	3.6
Means.....			56.9			21.7			23.196		16003.1			3.5

*First 12 days.

†Last 10 days.

Precipitation, 1893.

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Laramie.....	Trace.	0.11	0.29	0.32	0.33	0.54	0.34	1.08	0.39	0.28	0.06	0.10	3.84
Lander.....	Trace.	1.24	0.84	3.20	2.17	1.06	0.25	1.12	0.43	0.43	0.48	0.40	11.62
Saratoga.....	0.40	0.90	0.85	2.00	2.70	0.80	0.55	2.24	0.80	1.48	0.70	1.10	14.52
Sheridan.....	0.35	1.20	0.33	1.20	3.40	0.88	0.31	0.12	1.57	1.04	1.40	0.80	12.60
Sundance.....	0.80	1.60	0.90	1.45	3.49	1.75	1.75	0.97	0.46	1.84	0.50	1.06	16.56
Wheatland.....	0.20	0.40	1.00	1.40	0.90	0.10	0.55	0.27	Trace.	0.60	0.30	0.70	6.42
Cheyenne.....	0.08	0.87	0.78	1.36	1.64	1.33	0.69	1.14	0.29	0.22	0.29	0.53	9.22
Bates Park (Freeland).....	0.20	1.20	0.73	3.30	2.80	2.20	1.90	0.45	0.15	1.25	0.80	2.30	19.25
Treloa.....	0.08	0.70	0.58	Trace.	2.85	1.17	1.31	0.51	0.30	0.97	0.25	0.99	8.27
Inyan Kara.....	0.08	0.20	0.70	Trace.	2.85	2.45	1.53	1.28	0.30	0.97	0.25	0.99	8.27
Hat Creek.....	0.50	0.90	0.70	Trace.	2.85	2.45	1.53	1.28	0.30	0.97	0.25	0.99	8.27
Sybilie.....	0.16	0.36	0.38	1.09	1.08	0.72	1.46	0.76	0.26	1.21	0.74	0.99	8.27

GENERAL SUMMARY.

Highest Temperature.—Laramie, 87.2, July 21; Lander, 94, July 19; Saratoga, 89, July 21; Sheridan, 102, July 20; Sundance, 96, July 22 and Aug. 6; Wheatland, 108, June 18.

Lowest Temperature. — Laramie, —9.2, Feb. 27; Lander, —10, Feb. 14; Saratoga, —13, Jan. 16; Sheridan, —45, Feb. 1; Sundance, —31.5, Jan 31; Wheatland; —16, Jan. 28.

Highest Daily Range of Temperature.—Laramie, 45, Sept. 14; Lander, 45, Jan. 26; Saratoga, 53, Jan. 30; Sheridan, 55, Oct 21; Sundance, 49, Feb. 4; Wheatland, 55, March 30.

Lowest Daily Range of Temperature.—Laramie, 0.5, Dec. 2; Lander, 3, March 22; Saratoga, 5, April 25; Sheridan, 0, April 29 and Nov. 17; Sundance, 2, Feb. 5, April 24 and May 24; Wheatland, 0, April 17.

Highest annual mean temperature, 48.8, Wheatland.

Lowest annual mean temperature, 39.3, Saratoga.

Average annual mean temperature for six experiment farms and Bates' Park (Freeland), 42.7.

Killing Frosts.—Laramie, June 6 and Aug. 16; Lander, May 24, 25, 26, 27, and Sept. 22 and 23; Saratoga, light frosts June 14 and 24, killing Aug. 15 and 27; Sheridan, May 27 and Sept. 23; Sundance, May 22 and Sept. 23; Wheatland, light frost May 19 and killing Sept. 23, 24 and 25.

Greatest annual precipitation, 19.25 inches, at Bates' Park (Freeland).

Lowest annual precipitation, 3.48 inches, at Laramie.

Average precipitation in 1893 for the places furnishing complete records, as given in the table, 11.36 inches.

OTHER OBSERVATIONS AT LARAMIE.

Highest terrestrial radiation, 11.0, Sept. 8.

Lowest terrestrial radiation, 0.0, Feb. 1, April 25,
May 6.

Lowest relative humidity, 9.2, Jan. 8.

Méan relative humidity for the year, 56.9.

Highest dew point, 54.5, July 26.

Lowest dew point, —16.0, Jan. 16.

Mean dew point for year, 21.7.

Greatest monthly evaporation, 9.35 inches, July.

Total evaporation for six months, May to October,
inclusive, 37.525 inches.

Highest barometer, 23.418, Sept. 1.

Lowest barometer, 22.501, Jan. 31.

Mean barometer for year, 23.196. [Record not
complete.]

Prevailing direction of wind, southwest and west.

Greatest velocity of wind, 68 miles per hour, May 25.

Total number of miles traveled by wind in year,
127,236.8.

Greatest number of miles traveled in one month,
12,500, March.

Lowest number of miles traveled in one month, 9,139,
June.

Average number of miles traveled in one month,
10,603.1.

Greatest number of miles in one day, 713, March 12.

Lowest number of miles in one day, 54, Nov. 30.

Mean daily distance, 348.6 miles.

Mean hourly distance, 14.5 miles.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION, LARAMIE, WYOMING.

BULLETIN NO. 18.

JUNE, 1894.

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- I. The Reclamation of Arid Lands.
 - II. The Harvey Water Motor.

BY THE DIRECTOR.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

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Introduction.

It may be stated as introductory to this bulletin, that back of the agricultural interests and development of the State stands the problem of irrigation laws which effect the control and distribution of the water supply; and back of this irrigation question, also, arises for solution the problem of land laws suited to the conditions of the arid region.

The rapid development of the agricultural resources of the State, therefore, depends upon a wise solution of the problems of irrigation and land laws in the several states. The cultivation of our large and fertile valleys cannot go forward without actual settlers and cultivators of the soil; but before capital and colonies will enter upon the reclamation of these fertile lands, laws must be enacted in harmony with natural conditions which will at least insure the success of the farmer, and a reasonable return upon the capital invested.

Our arable public lands are about exhausted—only the broad prairies of the arid region remain unoccupied—while the demand for homes and small farms is as great as ever in the United States. The problem, therefore, of utilizing the arid lands and developing their resources by irrigation, thrusts itself upon the nation, and especially upon the people of the several arid States.

It is unfortunate that in some localities this question should have been mixed up with politics by partisan individuals. It is not, and cannot be, a political question, because it involves the welfare of all the people in the State without regard to party relations. It seems to be a

domestic question concerning the people resident in the arid regions; and their judgment and experience will be found essential to a proper solution of the question.

It is the purpose of this bulletin to aid the people in the solution of this problem so vitally related to the future welfare of the State, by giving the facts and collating the principles which enter into its solution. In doing this, we shall endeavor to tersely state the great facts of experience which irrigation in all countries has made prominent, and to suggest to the people of Wyoming the methods and procedure which have proved of value in other localities. We believe that when the people are fully awakened to the importance of this subject, their common sense, expressed through their representatives, will find a happy solution, which will greatly advance the agricultural interests of the State.

The Wyoming Agricultural Experiment Station can never reach its highest efficiency in encouraging and developing the agricultural resources of the State until this problem is solved, and our valleys covered with an industrious class of people devoted to the cultivation of our fertile lands. Therefore, in the issuing of this bulletin, we are endeavoring to get back to the bed-rock principles which enter into the agricultural development of the State.

A. A. J.

The Reclamation of Arid Lands.

A. A. JOHNSON.

BASAL PRINCIPLES OF THE PROBLEM STATED.

The correct solution of this problem depends on sticking to a few fundamental principles, which may be outlined as follows:

• 1. Every holder of irrigable public land, whether State or United States, should be required to reclaim it or transfer it to some one who will. This principle requires a change in our federal land laws to meet the conditions of the arid regions.

2. We must recognize the fact that all arid lands are not capable of being reclaimed and irrigated. The coming land laws must provide for their disposal and management as grazing lands, and make it possible for the owner of a small irrigated farm to also own some of the grazing lands.

3. Our mountain forests, the home and fountain of our water supply, must be preserved at all hazards.

4. In the arid regions, land and water are one and inseparable. Therefore the land and the water must go together. Owners of land must also own the ditches and canals which make it productive, and owners of ditches must be interested in the land they reclaim. We can never get away from this principle of nature, and be successful. There must be no water monopolies. As our State Engineer puts it: "We want no such vassalage as divided control of land and water creates."

5. Our State, through our State Engineer and Board of Control, must be continued as the guardians of our water supply, so as to effectively protect the rights of the appropriators, and prevent the waste of our water supply and the wrong use and diversion of our streams. This power of the State ought to be supreme under proper legal restrictions; and the United States land laws should be so amended as to recognize the importance and supreme right of the State to control and appropriate its water supply, as well as to protect its priority of rights on interstate streams.

6. The construction of large irrigation works must be under state control, and according to some pre-arranged plan which will secure the reclamation of the largest body of land at the minimum of cost, due regard always being given to the permanency and durability of the works constructed. The State can easily reach this matter by requiring parties building ditches and canals to secure the approval of the State Engineer as to plans, methods of construction and location, before water rights are granted and right of way across the public lands is allowed. A failure to comply with the plans approved may be made grounds of forfeiture of rights acquired.

These six principles are fundamental, and cannot be ignored without inviting disaster and defeat, and precipitating endless litigation and trouble. These principles recognize the importance and right of the State to reclaim its own arid lands under the sanction and co-operation of the Federal land laws.

PRESENT LAND LAWS.

The past five years have demonstrated the fact that

in Wyoming the present Federal land laws are unfavorable to the reclamation of large bodies of land by irrigation. This grows out of the fact that large and expensive canals are required in order to divert the water of our rivers and get it above these valuable lands.

The Federal land laws are unfavorable to the reclamation of these large bodies of land because they prevent the State from offering inducements to colonists, as well as guaranteeing safety to the capital required. Capital has no protection in the lands reclaimed unless the lands can be speedily colonized so as to secure users of water in sufficient numbers to make the water rentals pay dividends on the capital invested. This is so precarious and uncertain that capital will not venture to undertake such large outlays of money as are required in Wyoming.

It has been demonstrated that colonists are afraid of water monopolies, and are slow to settle on lands where they do not control the water supply needed in their work of reclamation and irrigation. It is an admitted fact that the homestead law does not fit the conditions of the arid regions, and the desert land law is of no value in spreading out our rivers by means of large canals. It has been well said that under these laws "the acreage is too small for the large ditch-builder, and it is too great for the purpose of the actual settler. There is not one immigrant in ten thousand who comes to the arid region to find a home, who has means to reclaim and cultivate 320 acres of land under irrigation, especially in the valleys where expensive canals are required to divert the water from Wyoming streams."

Thus it happens that large bodies of our most valuable lands are unreclaimed, and our agricultural population

small, because the United States land laws do not fit the conditions of the arid region.

Any one who will investigate the facts will find that the Federal land laws need to be amended in order to encourage the reclamation, settlement and cultivation of the agricultural lands in the arid region.

Wyoming has, in round numbers, 63,000,000 acres of land. Of this amount, at least 10,000,000 acres are suitable for agricultural purposes, much of it exceedingly rich, and lying at a favorable altitude for the successful raising of agricultural products. Of the remaining 53,000,000 acres, there are 22,000,000 acres of mountains, exceedingly valuable because of their minerals, timber, and as the storage basins of our water supply. There are 13,000,000 acres of coal lands in Wyoming, largely undeveloped, thus leaving 18,000,000 acres of high table-lands, suitable only for grazing purposes, very little of which can ever be reclaimed by high-line ditches and canals. The 10,000,000 acres of agricultural lands are fertile, and exceedingly valuable, when considered in their relation to the development of the mineral resources of the state.

METHODS PROPOSED.

The literature upon this subject presents four plans for securing the reclamation of the arid lands, which are now prominently before the country. Two of these plans provide for the exercise of jurisdiction and control over the work by the authorities of the national government; two provide for the exercise of such control by the authorities of the several states. The plans proposed for the prosecution of this work by the national government

are: First, the building of ditches by direct appropriation from the treasury of the United States, the work to be done according to plans provided by government engineers, and under the supervision of government officers. The second of these plans provides for the work being done by private parties, who are given a lien upon the land to be reclaimed as security for the return of money invested in the construction of large canals; but the supervision of the work, the control of the lands, and the control of the water supplies to be under the jurisdiction of the national government. The plans suggested for the prosecution of this work under State control are: First, the preparation of plans and the construction of works by State engineers, and the money to be provided by direct appropriation from the treasury of the State by acts of legislation, or the sale of bonds which the State guarantees and protects by proper legislation. Second, the construction of ditches, canals and reservoirs as private enterprises, but under plans prepared by the State engineer; the parties constructing the canals to be secured in their investment of capital by a lien on the lands reclaimed.

Another plan for carrying out this work has been suggested and discussed by the press of the country, viz.: That Congress should make absolute appropriations or donations for the construction of canals and reservoirs as it makes appropriations for the rivers and harbors. But such a plan has never been advocated in Congress. Many of the best lawyers of the country hold that Congress would have no constitutional right to make such appropriation, and a plan of this nature would no doubt meet with unanimous opposition from other sections of the country.

Another solution proposed for the difficulty is to let the lands remain in the hands of the national government to be administered through our Interior Department under amended Federal Land Laws which meet the conditions of the arid region, and which are based upon the fundamental principles previously stated, the work of the reclamation of the arid lands to be carried forward by an act of Congress by which the proceeds arising from the sale of public lands in the arid regions should be given to the respective states for internal improvements, to be expended and controlled by the authorities of each state. Besides the building of roads and bridges out of this fund, the large amount thus realized by the State could be expended in the construction of large canals and reservoirs which the respective states would own and control as they do the water in the natural streams. This would give to each state a fund out of its own resources to begin the work of reclaiming large bodies of land, the actual farmer and settler to be allowed to attach their laterals to these large canals and reservoirs without expense, and under priority of right to secure the amount of water necessary to irrigate the amount of land which they could successfully cultivate.

The method which has provoked the most discussion and perhaps the greatest popular interest is the ceding of the arid lands to the respective states, so that each state may work out its own destiny under state legislation in dealing with this domestic question (for such it seems to be with all the arid states). This matter has been brought prominently before the people of the United States by the Warren Arid Land Bill, which proposes to cede all the arid lands to the respective states; and by the Carey

Land Bill, which proposes to cede to the states a limited number of acres under conditions which provide for the state's reclamation of the land ceded to the respective states; both of these bills being based upon the fact that reclamation of arid lands is a domestic question which should be relegated to the states interested in this problem.

Mr. Joseph Nimmo, Jr., a special agent of the Department of Agriculture, after making a trip in the study of this question, through Montana, Washington, Idaho, Wyoming and Colorado, reports a decided sentiment in favor of ceding the arid lands to the several states. Mr. Nimmo states that the reasons advanced for the irrigation and ceding of lands of the arid regions are set forth quite fully in memorials to Congress adopted by the legislatures of Wyoming and Idaho. The ground upon which these memorials and the public sentiment appear to rest are as follows:

“(1) The proposition that the irrigable and pastoral lands of the Arid Region should be donated to the states has abundant precedent in the donation of swamp lands to the states, and also of lands for schools, seminaries and agricultural colleges, and for public improvements. These donations of lands have been about as follows:

	<i>Acres.</i>
Swamp lands.....	80,200,000
Lands for schools, seminaries and colleges.....	78,800,000
Lands for public improvements.....	7,800,000
Total	166,800,000

“The total area of irrigable land in the Arid Region is estimated at about fifty million acres. Previous estimates which made it over one hundred million acres are now regarded as erroneous. No estimate has been made as to the area of pastoral lands, which are in the aggregate

of much less value than the arable lands will be when irrigated.

“(2) By the terms of the charters of the several Rocky Mountain states, the waters thereof are the property of the State. This was first expressed in the constitution of Colorado, as follows: ‘The water of every natural stream not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and is dedicated to the use of the people of the State.’ This is in the nature of an irreversible compact.

“(3) Besides the compact just referred to, the Supreme Court of the United States has declared the right of the states to control the distribution and ownership of water, and Congress has by statutory enactment also recognized this right. (U. S. Rev. Stat. 2339 and 2340). Just here it is proper to observe that throughout the Arid Region values inhere in the water and not in the land.

“(4) The administrative features of the law of appropriation for beneficial uses are peculiar, differing necessarily in the different states, and in different parts of the same state. Privileges which would be applicable to certain streams and in certain localities are not applicable to other streams and in other localities. The enactment of laws which shall meet all these exigencies requires personal and experimental knowledge of the subject of irrigation.

“(5) The administration of the law of appropriation for beneficial uses involves the determination of such questions as the following:

“(a) Questions as to priority of appropriation.

“(b) Questions as to preferences which shall be granted to the use of water for domestic uses, for agricultural uses, and for manufacturing uses, and generally touching the practical application of a doctrine of law upon this particular subject.

“(c) Questions as to the limits which must be placed upon the total area of lands which the waters of particu-

lar streams are sufficient to irrigate, and which such waters can be permitted to serve.

“(d) Questions as to the economic and proper use of water.

“(6) Congress will always be composed very largely of Senators and Representatives familiar with the law of riparian rights, but unfamiliar with the law of appropriation for beneficial uses. This latter law must necessarily prevail in the Arid Region, with all the consequences of that law, vitally affecting the material interests of the people.

“(7) The people of the Arid Region believe that for reasons above stated, Congress will never be able to legislate wisely, or beneficially in regard to the interests of the people.

“(8) To the objection that the power of disposing of the public lands, if conferred upon the States, might be a source of corruption, and an instrument of partisan struggle in the several states, the reply is made that the whole subject will always be open to a general public scrutiny which will operate as a barrier against such prostitution of the power conferred.

“(9) While the United States government retains the ownership of the lands, and disposes of them under the provisions of laws not at all in harmony with the principles which govern development by means of irrigation, there must necessarily arise conflicts between the administration of State and National laws.

“(10) The cost of irrigating works must be realized out of the profits arising from the improvement of the land reclaimed. This is evidently the natural and proper mode of development. In this way the largest results in irrigation have already been achieved. The land laws of the United States not only prevent this, but worse still, so operate as not only to enable but to incite individual land claimants to thwart the plans of companies which are inclined to enter upon large schemes of development, and

to reclaim lands which cannot be reached by private enterprise.

“(11) The memorials of the States of Wyoming and Idaho declare that the progress of those States has been greatly retarded by the fact that corporate capital has not been enabled to engage in the work of building the larger irrigating works, designed to reclaim lands which cannot be reached by individual enterprise.

“The memorial of the State of Wyoming states that ‘if the late Territory of Wyoming could, during the past five years, have controlled the disposal of the irrigable lands within its borders, it could, while disposing of it to actual settlers only, have afforded such protection to canal companies as would have given our agriculture four times its present importance and more than doubled our population.’

“The memorial of the State of Idaho embodies this precise language, except that it says *ten years* where the Wyoming memorial says *five years*.

“(12) The subject of irrigation is evidently not one which, like the rainfall, can be left to the operation of natural forces, even after the reservoirs and natural ditches are constructed; but it is one which all experience proves must be made the subject of constant governmental supervision and control. Wherever irrigation is practiced, such supervision and control is regarded as a public function. This inheres in the fundamental doctrine of law regarding the subject of irrigation, viz., that the water transported is the property of the public, and that the State must administer the distribution of the public supply.

“(13) It appears to be clear from the foregoing that the regulation of the water supplies of an irrigated district has no analogy in transportation affairs, nor in the ordinary commercial and industrial operations, but must be classed with those industries which, like the coinage of money, the carriage of the mails, public instruction, etc.,

are from the dictates of experience and of reason regarded as absolutely or in certain particulars public functions.

“(14) During the last seventy years the national government has simply acted as the agent and trustee of the people regarding the sale of the public lands, without treating them as a source of national revenue. This is a settled feature of our national policy. It is believed that this agency and trusteeship can now be safely transferred to the States of the Arid Region.”

It would seem that this whole problem must be kept in the hands of the people, and worked out under wholesome national and state legislation which shall protect and encourage capital, as well as secure lands for the use of the actual settler who will be induced to come to the arid states because of the success which awaits them through reclaimed lands under the security of wise and equitable laws.

CONCLUSIONS OF THE BRITISH COMMISSION,

On December 23rd, 1884, the British government appointed a royal commission on water supplies and irrigation. It was the duty of this commission to investigate the subject of irrigation in Egypt, Italy, India and the United States, with a view of compiling this information for the guidance of legislation on the subject of irrigation for the province of Victoria. This commission made a special study of irrigation laws, water rights, and methods of constructing large irrigation works in the various countries visited. They have made various progress reports from time to time which have been printed by the British government in Australia. These reports contain much valuable information, and have led to the adoption of the system now practiced in Victoria, which is regarded as

combining the wisdom and best methods on irrigation that can be culled from the practice of the world.

On the subject of irrigation in Italy, the British commission makes the following statement:

“In the first place, it is important to note that almost all the irrigation canals in Piedmont and Lombardy now belong to the State, and the fact is all the more striking when it is remembered that a majority of them were originally constructed by private enterprise. The reason for this change of ownership is not difficult of discovery. As Baird Smith notes, the dangers arising out of monopoly of water, apart from the ownership of the soil, have commended their purchase to the statesman. Both processes, starting out on different principles, have arrived at the same conclusion. The Lombard practice of never separating the water from the land has palpably produced most beneficial results, and, in his judgment, was the chief cause of the rapid multiplication of secondary canals constructed by the private enterprise in that province.

“In Piedmont, the State's proprietary of the water has been almost equally efficacious in encouraging its equitable distribution; but its ownership of the head-works has come to be recognized in each as the best means of insuring justice to the irrigator.”

The commission further states that “Italian experience, French experience and Spanish experience all go to show that the interests to be studied in relation to irrigation schemes are so many and so various, and so intimately bound up with the public welfare, that State control is imperatively necessary, and that for the protection of its citizens no monopoly can be permitted which would separate property in water from property in land to which it is to be applied. But at the same time it is established that while a general central control by the State is essential, the business management and distribution of the water is much better placed under the local

authority, as this is more effective in its supervision, more economical in its administration, and is educational, also, in a political sense, to a high degree. The establishment of a comprehensive system of irrigation by private enterprise is possible only under unusual conditions. If it embraces many sources of supply, large areas, or conflicting interests, it is impossible. The capital required is large, the returns are not rapid, and the full benefit secured by the close occupation and complete utilization of considerable areas are so reduced that the State could reach those benefits in unnumbered ways, and settlers are not justified in assuming large responsibilities in their initiation. This becomes palpable when it is perceived that as in Egypt and Italy, carefully matured schemes insure an enormous agricultural production, and the stable prosperity of a large number of producers. It may be safely asserted from foreign experience of many generations that irrigation is one of the soundest national investments, where engineering ability and executive work are expended upon large canals, which are afterwards taken under local control, guided by a carefully compiled code of water laws and regulations, while the land whose production is enhanced is charged with the interest upon the capital expended in supplying it. All of these conditions we ought to possess in Victoria."

In conclusion, the commission makes the following important statement:

"Over and above all differences, and apart from all advantage and disadvantage, there are certain special lessons to be learned, even from a cursory glance at the field of knowledge bearing upon irrigation in Egypt and Italy. In both, the supreme control of the water is vested in the State, and in both the most important works are undertaken by the State, or under its supervision. In both it is demonstrated that no lesser authority can be intrusted with so vital an element of national production. But on the other hand it is found in each country that the State is incapable of satisfactorily discharging the admin-

istrative task of distributing the water to individuals, or undertaking its delivery at convenient times, of supervising its measurement, or the canals by which it is conveyed, or to collect its dues in an inexpensive manner.

"In Egypt the village commune; in France and Spain the association, and in Italy the syndicate, intervene between the State, which owns the water, and the individual who purchases it, while in the first directly and in the last indirectly the State has its advances secured upon the land which is watered. This system is unknown in America; for though state ownership of water is secured in the constitutions of Colorado and Wyoming, there are colonies in California which partake of the communal principle, although the two are not conjoined. There are no State works, but virtually those private persons who construct them do so upon the security of the land benefited. The best American opinion, however, is in favor of such a system of divided responsibility between the settlers and local government, and it has been envied and admired by eminent Indian authorities as well. We are therefore able to claim that the policy adopted in Victoria is in accord with the judgment of those most competent to form an opinion in Europe, Asia and America."

The investigations of this British commission led to the adoption of what may be called the "communal" principle for reclaiming the arid lands of Victoria. Water Trusts are formed somewhat similar to the Irrigation District in California under the Wright Act; but these Water Trusts by law are under governmental control, and can only be carried forward by the sanction of the government, which passes upon the feasibility of the scheme, and also the available water supply for the uses of the proposed Water Trust. The irrigation act of 1886 in Victoria declares the water of all streams to be the property of the Crown, provides for the extinction of any riparian rights that might prevent the use of water for irrigation, author-

izes the construction of national works by the State, and enables Trusts directly elected to carry out their schemes with money advanced from the public treasury. The success of this method of reclaiming the lands in Victoria is shown by the following statement:

“When it is recollected that the first Trusts in the colony were not formed until 1882, and the first Irrigation Trust not until 1884, the progress that has been made may be estimated in a general way from the fact that there are now twenty-four ‘Water Trusts’ covering an area of 6,300,000 acres, and six Irrigation Trusts covering an area of 356,788 acres, in addition to fifteen applications for the constitution of new Irrigation Trusts which will cover nearly 2,000,000 acres more.”

This commission, out of the various facts gathered by investigation, have enunciated several very important principles which have been applied in the solution of the problem of irrigation in Victoria, which are as follows:

“*First.* In any distribution of water under the authority of the State, owners of the land must be deemed to have a preferential claim on the sources of supply for enough to meet any reasonable domestic requirement and for the watering of stock up to the full carrying capacity of their pastures.

“*Second.* It is necessary, therefore, that before authority be granted to carry out schemes, and the requisite funds advanced, the government be well assured the proposals are sound, both from an engineering and financial point of view. It is also essential that they should be satisfied that the body of rate-payers on the area on which the cost of the work will fall are agreed as to its necessity, and that the proposed expenditure thereon will be judicious, and the benefits a fair equivalent for the annual charge entailed.”

It would seem from the above facts and conclusions of the British commission that they had adopted the Irri-

gation District principle now in vogue in California under what is known as the "Wright Act;" that the communal principle and the irrigation district principle are similar, except that in Victoria the government oversight of the Irrigation Trust is so strong and vigilant as to prevent abuses and failures, which have sprung up, in some instances, under the Irrigation District system of California.

So far as we have proceeded in this matter as a State, we have made no mistake in our legislation. We have observed the fundamental principles which underlie the problem, and are now the admiration of the students of the problem of irrigation in the West. In the State's control of the water with its system of administration, we find that under the laws of 1890-91 provision is made for the formation of Water Divisions for administrative purposes. The Superintendent of each Water Division, who is appointed by the Governor, by and with the consent of the Senate, together with the State Engineer, make up our State Board of Water Control, whose duties are clearly outlined by law. Now it would be an easy step, in harmony with present irrigation laws, to make provision for the creation of Irrigation Districts upon the communal principle of Victoria, with municipal or quasi-municipal powers for the sole purpose of reclaiming land. These Irrigation Districts would vary in size according to locality and the amount of land to be reclaimed from and under the same system of ditches. Our present system of water control would still stand as an excellent method of State control and administration of our water supply, by which all parties would be protected in their priority of water rights, and in the adjudication of disputed claims.

Summed up in a few words, the Irrigation District,

under the statutes of California of 1887, is a municipal corporation, having the same powers to construct irrigation works and to furnish all lands within it water for irrigation, that are possessed by a city or incorporated town to construct water works and to furnish water for its inhabitants for all domestic purposes. These powers are familiar to all and are readily understood.

CONCLUSION.

1. It seems quite clear from all the facts under consideration that if the Federal land laws are to remain unchanged, and the United States is to remain the owner of the large bodies of public lands in the Arid Region, then their reclamation must be undertaken by the national government, for private capital will not enter upon this work under the conditions now prevalent and imposed by the present Federal land laws.

2. While the United States retains control over the public lands in the Arid Region it is impossible for the States to adopt the communal principle of Victoria, or the Irrigation District system of California.

3. It, therefore, follows that the Arid Region of the West must remain undeveloped and uninhabited unless the arid lands are ceded to the respective States, so that each State may work out its own destiny under wise legislation.

We have no desire to advocate any system or method in this Bulletin, but to call attention to the fact that the agricultural resources and possibilities of the Arid Region cannot be fully realized, and utilized, until this irrigation problem is solved by wise National and State legislation.

The Harvey Water Motor.

A NEW INVENTION FOR IRRIGATION PURPOSES.

The Platte River, one of the largest streams in Wyoming, has not been largely utilized for irrigation purposes because of the peculiar topography of the country through which it passes, and because of the great expenses incurred in building canals with sufficient fall to utilize the waters of this stream for the purposes of irrigation.

The peculiarity of its banks has made it difficult to build head-gates, which would enable ranchmen of moderate means to take out the waters of the stream. Only long and high-line canals which cost into the hundreds of



VIEW OF PLANT, LOOKING UP STREAM.

thousands of dollars for construction, can divert the waters of this stream to advantage. Thus upwards of 350,000

acres of bottom lands have remained unimproved and unoccupied, while enormous quantities of water in the Platte River have gone to waste, which would have made these



VIEW OF PLANT, LOOKING DOWN STREAM.

uninhabited tracts of land bloom with luxuriant vegetation.

Mr. F. H. Harvey, of Douglas, Wyoming, has apparently solved the problem of irrigation for the Platte Valley in Wyoming. His ingenious plan for raising the waters of the river has, so far, proved a success; and it seems that the practical demonstration of his plan, because of its cheapness, simplicity and ability, is going to work a revolution in the methods of taking out water from the Platte River for irrigation, as well as along other streams of like characteristics.

We are indebted to the *Irrigation Age* for the cuts which we insert, fully illustrating Mr. Harvey's new water motor and its method of raising water for the purposes of irrigation. We quote Mr. J. A. Breckons' description of

this motor and its relation to the Platte River, as given in the *Irrigation Age* of June, 1894. We have personally inspected the wheel, and regard Mr. Breckons' description as accurate and complete.

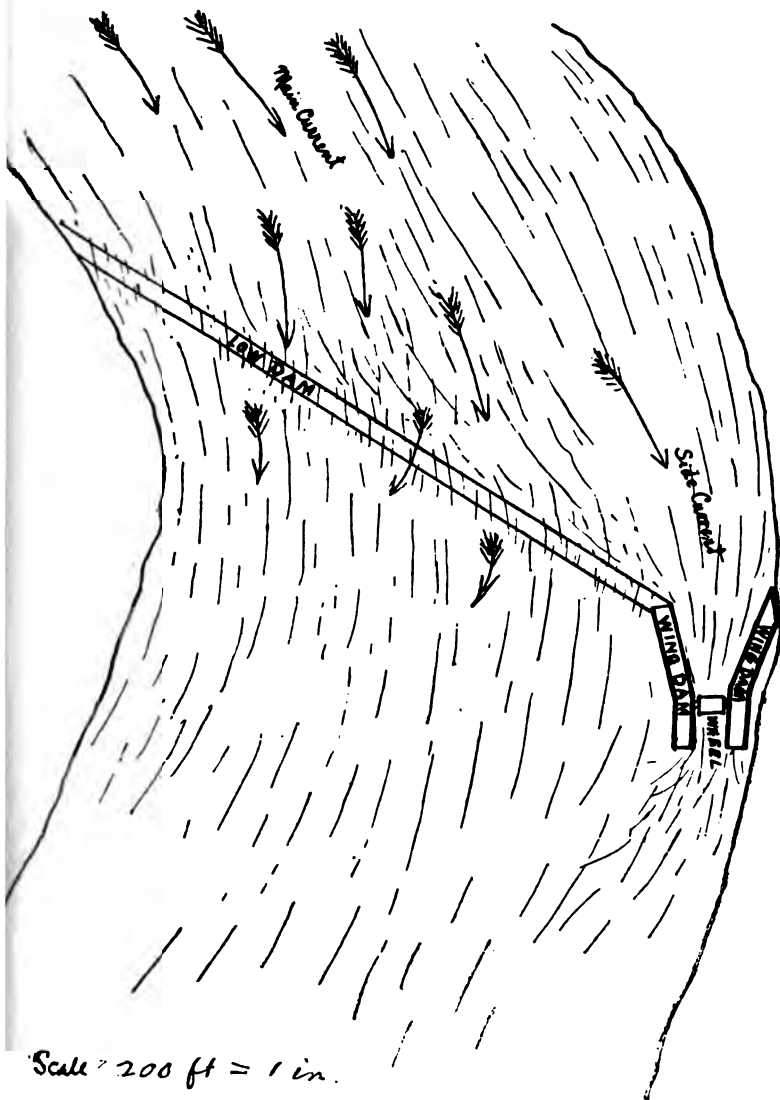
"The Platte River, in its course through Wyoming, alternately runs in almost level stretches of several miles and then in rapid falls of from 30 to 60 inches in short riffles. Below the riffles, on either side of the stream, are the bottom lands laying with a gentle slope to the river and admirably adapted to irrigation.

"Mr. Harvey has located his motor on one of these riffles, three miles above the town of Douglas, and is now watering 200 acres with it. The motor has sufficient capacity to water 500 additional acres. The river at this point is about 850 feet wide and makes a sharp curve at the head of the riffle. A low dam of piles and loose stones starting at the head of the riffle was first con-

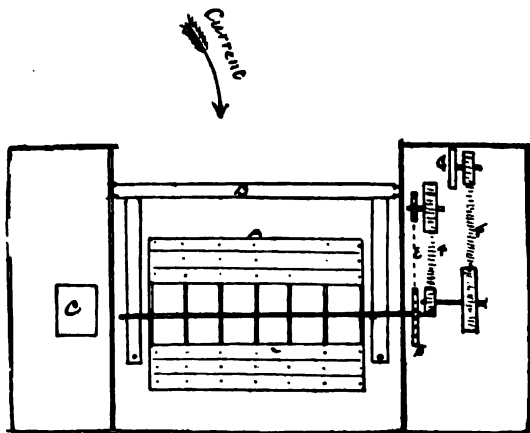


VIEW FROM TOP OF PLANT.

structed diagonally from the right bank of the stream to a point about 150 feet from the left bank. From the end of this dam a strong wing dam 10 feet wide and 12 high,



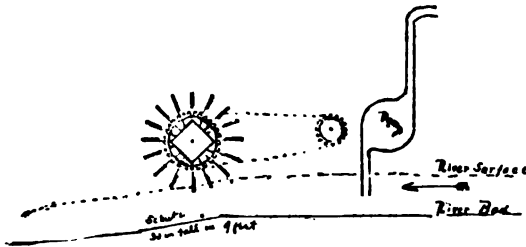
made of piles, plank and loose stone, was built, extending at an angle of almost 20 degrees towards the shore for 50 feet, and then for 12 feet directly down the stream parallel with the shore. A similar wing dam was constructed from the shore, the two forming a letter Y, with the stem down the stream. The main current of the the stream passes over the low dam, but a side current is directed by it into the Y where the water-wheel is placed. The wheel is a combination of an undershot and breast wheel. The 30 inches of fall which the river makes in the riffle is concentrated in the chute carrying the water through the Y. With a 10 foot diameter wheel, 14 feet long, 60 horse power is secured. This in the Harvey plant is used at present time to run a 3½ inch centrifugal pump, which raises 1,000 gallons of water per minute a height of 16 feet. The same power will run a 5 inch pump, raising 7,000 gallons per minute. The wheel is hung on a swinging frame and is balanced by a counter weight. Its gearing is a sprocket wheel so that it can be raised or lowered with the varying rise or fall of the river



without any readjustment of gearing. Logs have been run under it and it has ridden over them like a pneumatic-

tired bicycle passing over a rail or stick without injury to the wheel or jar to the pumping machinery.

"The wheel was started on April 17th, a large party of Douglas citizens being present, and has been running



continuously day and night since that time at an expenditure of about *one cent* per day, this expenditure being for oil on the pump connections. No engineer or watchmen is needed and the wheel works on while the owner works in the field or sleeps, every 24 hours pouring 1,440,000 gallons of water on the thirsty land.

"The cost of the wheel, compared with what it accomplishes, is nominal. Labor and material, including the pump on the Harvey plant, amounted to \$1,200. As much of the work was experimental it was necessarily slow. A like plant can be put in for \$800, and most of the work can be done by the ranchman himself.

"Since the wheel has been running, scores of ranchmen have visited the plant and preparations are already being made to put in four plants at various places along the river, one of them, where the riffle has a fall of 50 inches, to be of 100 horse power.

"Mr. Harvey will not undertake to patent any feature of his motor, and will cheerfully furnish information as to its construction to anyone. The enhancement in value of his own property, and the satisfaction of seeing central

Wyoming develop, is all the reward he wishes for his invention."

We trust this new water motor for the purpose of irrigation, will awaken great interest among the ranchmen of Wyoming who are living along our large streams. We believe it to be a cheap, reliable and effective method of taking water out of our large streams for irrigation, and after personal inspection, can fully endorse this motor, believing that the information herewith given may prove of great value to the agricultural interests of Wyoming.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,
LARAMIE, WYOMING.

BULLETIN NO. 19.
SEPTEMBER, 1894.

SQUIRREL - TAIL GRASS.

(FOX - TAIL.)

One of the Stock Pests of Wyoming.

BY THE BOTANIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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SQUIRREL-TAIL GRASS.

(FOX-TAIL.)

One of the Stock Pests of Wyoming.

AVEN NELSON.

In the winter of 1892, while cleaning some sheep skulls for comparative work in anatomy, the writer's attention was first called to the remarkable malformations and diseased conditions of the jaws of stock to which had been fed, for a time, hay containing even a small quantity of the matured grass elsewhere commonly known as Squirrel-tail or wild barley, but in Wyoming more usually as Fox-tail. Subsequent inquiry and investigation has developed the fact that the prevalence of this grass in the meadows of this state, and of the west generally, is so great and the injury such as to justify calling attention to it in this public way.

SQUIRREL-TAIL.—(*Hordeum jubatum* L.)

In this genus of grasses (*Hordeum*) belong the cultivated and wild barleys. The former are among the earliest grains of which we have any historical mention, and the wild barleys have likewise been known for a considerable time. *Hordeum jubatum*, the species under consideration, was known to Linnæus and has been frequently mentioned by agricultural writers since that time.

It seems to be sparsely distributed over a large part of North America and over parts of Europe and Asia. Soils

impregnated with alkali and other similar salts are particularly favorable to its luxuriant growth, possibly because other grasses do not thrive so well in such soils and hence do not crowd it out, rather than because such conditions are the most favorable. Wet lake and sea-shore meadows and cold, wet alkaline plains are rarely free from it. This will in part explain its rapid spread in this and our neighboring states, for with the extension of our irrigation systems the above conditions are being multiplied and the means for the rapid distribution of its seed are furnished. The land immediately adjoining irrigation ditches and low places, wet from seepage, as well as land flooded early in the season or on which the water has been allowed to stand throughout the winter and spring are particularly liable to be infested. The seed, distributed by the water of the ditches, by the wind, and carried by animals to which it clings by reason of its barbed awns, finds in such places suitable conditions and but slight competition from other plants.

All the grasses of the genus *Hordeum* are characterized by the presence of numerous awns or beards, which in several of the species are quite long, stiff, sharp and freely and strongly barbed. This quality has always condemned the wild species as forage grasses and relegated them to the noxious weeds, except as they have found a place in collections of ornamental grasses.

Hordeum jubatum, as well as the closely allied species, *Hordeum pratense*, have by all writers been excluded from the forage grasses because of the injuries inflicted upon stock to which they are fed.

That the fact of such injuries has been for a long time known is shown by the references made to it by agricul-

tural writers both past and present. The following is a quotation from Sowerby's *Grasses of Great Britain*: "In the days of equestrian travelling, one of the greatest recommendations of an inn, in the Isle of Thanet, where this grass is very common, was that of having hay without any admixture of Squirrel-tail."

ITS NUTRITIVE VALUE.

In the various chemical analyses of the grasses which have been made it has been shown that Squirrel-tail is not without nutritive value. In fact it ranks as high as some that are recommended for cultivation, but this signifies nothing when it is remembered that many other grasses are either equally or more nutritious and that their use is attended with no danger to stock. This being so, we must look upon Squirrel-tail as a weed whose eradication should at all times be sought.

BOTANICAL CHARACTERISTICS.

This grass is probably well known to most farmers and ranchmen, but if not its recognition will be a matter of no difficulty. With the aid of the following description and the accompanying plates, I and II, it will be an easy matter to distinguish between this and other grasses:

The head is compact but elongated and forms what is known as a spike. This is made up of a number of one-flowered spikelets, three of which are borne at each joint of the central stalk or rachis. Each spikelet has an awl-shaped rudimentary floret at each side, which is short awned. Six empty husks or glumes are borne on short stalks at the base of the perfect floret. These are the long, lateral, divergent awns, and are slightly shorter than the long central awn of the glume covering the perfect floret. The awns are hisped or barbed and so diverg-

ent as to give a very bushy appearance to the spike. At maturity the spike disarticulates and the awned seeds are left free to be carried everywhere by the wind. The grass grows in rather compact bunches eight inches to two feet high. The leaves are short and flat, the spikelets a very light green or yellow and very fragile.

INJURIES INFLICTED.

By observation and inquiry the following facts in regard to the injury inflicted by its use have been noted :

The awned heads when taken into the mouth break up into numerous sections, scatter about within the mouth and everywhere adhere to the mucus membrane, which soon becomes pierced with the long stiff awns. As the animal continues to feed more awns are added and those already present are pushed deeper into the flesh. Inflammation soon results and leaves the gums of the animal in a condition to be more easily penetrated. The awns are particularly liable to be pushed down alongside of and between the teeth. As the swelling and festering progresses the awns are packed in tighter and pushed deeper and cause suppuration of the gums as well as ulceration of the jaw bones and the teeth. Through the absorption of the ulcerated sockets and roots the teeth become loosened and even drop out, but the animal, impelled by hunger, still endeavors to eat such hay as may be offered. If the cause is continued the disease progresses till the bony tissue of the jaws is disarranged, the ulcers extend to all parts of the jaw bone and it becomes distorted and enlarged, somewhat as in Big-jaw (*Actinomycosis*). The spongy marrow-filled interior of the bone is by the ulceration changed into great cavities, filled with the broken awns (Fig. B.) This condition may continue

till the cavities. extend entirely through the jaw and the tightly packed awns protrude till they may be pulled out with forceps or fingers.

On the authority of a number of observant stockmen I learn also that in many instances the awns penetrate in like manner the palate bones and work up into the nasal passages. The throat and probably the stomach suffer similar invasions, and as the awns are heavily cutinized they do not, when they have entered the tissues, decay so as to permit of removal by absorption.

It is probable that all kinds of stock suffer to about the same extent, but as horses are more constantly hay fed it is more often remarked upon them than is the case in cattle and sheep. The latter, however, are subject to a new danger as well, for the awns are caught in the wool about the eyes and work into the tissues surrounding the eye and even into the eye-ball itself, in many instances causing total blindness. I have learned of one case in which this resulted to all of a bunch of calves that were turned in to feed out of a stack of hay containing a considerable quantity of Squirrel-tail.

In the accompanying plates, III, and IV, the effects upon the jaw bone is shown by comparison of the healthy condition with the diseased, and although these figures do not represent extreme cases, yet they reveal enough to completely condemn Squirrel-tail as hay.

The grass before it heads is said by some to form fair pasture, but stock on the range will not touch it after the heads mature and it is only when mixed with other hay that it gives trouble, as it cannot readily be separated.

THE CAUSE.

I have already referred to the cause of its spread and

prevalence in meadow lands. Being indigenous to this region and our soils in many places being better adapted to its growth than for the growth of other grasses, it needs only the requisite moisture for the production of a luxuriant crop.

Professor Cassidy, in his bulletin on Colorado Grasses, speaks of it as a product of over-irrigation, and this seems to represent the general concensus of thought on the question. The better meadow grasses readily compete with it for position under normal conditions but cannot endure constant flooding from ditches, especially during the early spring and summer.

It is also likely to appear on lands from which for any cause the other grasses, native or cultivated, have disappeared. This frequently happens where irrigation has been carried on for a number of years and is then abandoned. Under irrigation the original grasses are gradually replaced by those which thrive best with plenty of water but which soon perish when the supply is cut off and leave the field clear to be occupied by the first hardy invader.

THE REMEDY.

The eradication of this grass ought not to offer a very difficult problem to our ranchmen, and its prevalence is due rather to indifference on their part, owing to a lack of a full comprehension of the injury wrought rather than a lack of ability to cope with it.

The first suggestion is care in irrigation to prevent the occupancy of new territory. Next that steps be taken to get rid of it where it is now found. As it is an annual this should not be difficult, for if it is not allowed to seed it will not appear the next season. In fields where native

grasses are relied upon this may be accomplished by cutting such portions of the fields as show Squirrel-tail before it heads and repeating the operation often enough to prevent seeding for one season. If cut before heading it is fairly nutritious and gives no trouble in the hay. In fields of cultivated grasses that have become foul perhaps the best remedy is plowing and planting to other crops and seeding down new ground with clean seed.

A little care in this matter will fully repay the farmer and ranchman, not only by preventing the loss of stock but by the increased thrift and growth due to the proper nutrition of proper food. Nor is it to be forgotten that the market value of hay depends in part upon its freedom from this pest. No person who values his stock or desires to bestow upon animals under his care even ordinary humane treatment will feed hay in which it is found.

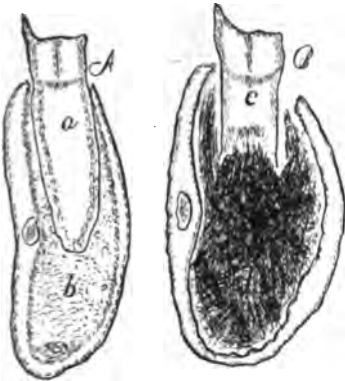


Fig. A.—Cross section of normal jaw bone; *a*, fang of tooth; *b*, marrow.

Fig. B.—Cross section ulcerated and enlarged jaw bone; *c*, decayed fang of loosened tooth; *d*, cavity in enlarged jaw, the imbedded awns removed.

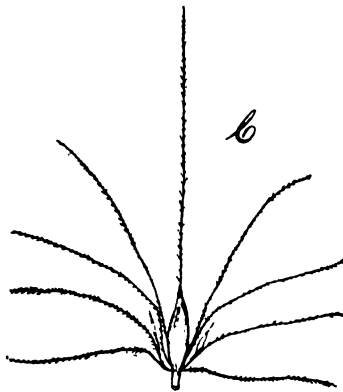


Fig. C.—A single seed, awns slightly reduced but barbs exaggerated to show direction. The awns probably penetrate the flesh broken end (seed end) first.



PLATE I.—*Hordeum jubatum* L.—A single plant showing character of leaf and fruit.



PLATE II.—*Hordeum jubatum* L.—A tuft of the grass as it usually grows.

NOTE.—Plates I and II we are able to present through the courtesy of Professor Crandall of the Colorado Agricultural College. They are from his bulletin on Colorado Weeds.





Fig. 1.



Fig. 2.

PLATE III.—Sheep jaws. Fig. 1—Normal condition. Fig. 2—As enlarged and ulcerated by "Squirrel-tail" hay.



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Fig. 3.

Fig. 2.

Fig. 1.

PLATE IV.—Sheep jaws, side view. Fig. 1—Normal condition. Fig. 2—Distorted jaws, ulcerated cavities packed with the broken awns. Fig. 3—Another jaw, the awns removed, showing its deep ulcerated cavities.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 20.

OCTOBER, 1894.

The Artesian Wells of Southern Wyoming:

Their History and Relation to Irrigation.

BY THE PHYSICIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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THE HORTICULTURIST IN CHARGE

The Artesian Wells of Southern Wyoming:

Their History and Relation to Irrigation.

J. D. CONLEY.

The problem of water supply, from whatever source, whether for commercial or domestic purposes, is of vital importance to the arid regions. The bills which have been passed by congress for the investigation of subterranean waters, and the appropriations made by it for the sinking of artesian wells, illustrate its great public interest. On June 16th, 1894, an appropriation was made for artesian wells at Pine Ridge, Red Bud and Standing Rock agencies.

We quote here from Washington correspondence, headed "To Locate Artesian Wells": "Washington, May 23, 1894.—Representative Doolittle (Wash.) has introduced a bill to appropriate \$100,000 for ascertaining the subterranean water supplies in the states of Idaho, Montana, Washington and Oregon lying east of the Cascade mountains, and ascertaining the localities at which artesian wells can profitably be dug."

Wyoming, so far as I know, has been exempt from such government aid—whether from her system of rivers and their tributaries giving her the best surface water distribution of any of the Rocky Mountain states; or from an oversight of those in authority to press her claims in this direction, we are unable to say; however, it is a fact

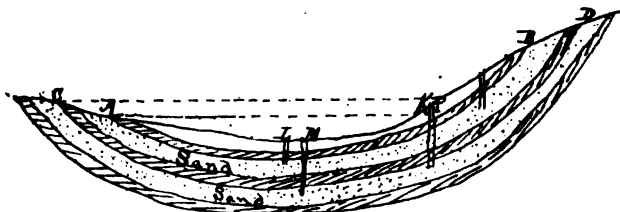
that in comparison with other states and territories, we have hardly made a beginning in this method of procuring water either for irrigation or domestic purposes.

By investigating the Biennial Report of the State Engineer of Wyoming for 1891 and 1892, one can see with what propriety he has divided the state into four natural water basins. We would naturally infer that there were the same number of artesian basins. There are at least as many, and probably many more.

THE CONDITIONS NECESSARY FOR AN ARTESIAN SUPPLY.

The source of water should be higher than the well, a pervious or porous stratum should be situated between impervious strata; and it is quite essential that the strata should be continuous, for if there is a fault in the stratum the water will come to the surface or be lost in subterranean currents. Such I believe to be the case at the Laramie City springs.

The following cut was obtained from the Colorado Experiment Station; it was used in Bulletin No. 16 on Artesian Wells. We also quote the description of the same from their Bulletin:



“The region where artesian wells are found is generally spoken of as an artesian basin, largely because the typical form of such a region is a genuine basin, with the rim higher than the center. A section of the Denver

basin is of this form. The figure may represent an exaggerated section of such a basin, with the porous strata outcropping at B, D, C and A. Anywhere lower than the line AK flowing wells might be expected if the strata are continuous, but as we reach K or some point nearer B, it will be found that water comes only to the surface, and still higher it may fail to reach the surface. It is also evident that while at P flowing water will not be obtained from the upper stratum, by going deeper it may be secured, because the outcrop of the stratum which furnishes it is higher.

“The figure also shows why the pressure is generally greater as the depth is greater. This fact has given rise to a popular belief that if one only goes deep enough flowing water will surely be obtained. Unless the proper conditions are present this is not true, and it is useless to expend money in that hope.”

There is some difference of opinion as to what constitutes an artesian well. It is generally applied to wells of great depth, whether it be a flowing well, or some force be required to bring the water to the surface; but it should be only applied to flowing wells, or to those that rise very nearly to the top of the ground. The name is derived from Artois, a province of France—not that they were used there first, for thousands were sunk in China centuries before; and it is quite remarkable to observe the similarity of the drills in use then and now. It has been proposed by some to distinguish between the two classes of artesian wells, calling those that flow positive, and those that rise to a considerable height but do not flow negative artesian wells. They are not dependent upon any particular geological formation. In northern Illinois

one might claim with a show of propriety that they are dependent upon the Silurian Age, for in the northern part of the state the Silurian is the prevailing surface rock, and in sinking artesian wells, they have to drill through the Upper Silurian and the Trenton of the Lower Silurian, and water is found in the next lower epoch, the St. Peter's Sandstone, or in the Calciferous epoch. Herewith is a typical well, as given by Prof. Worthen in volume two of the Economical Geology of Cook county, Illinois: "Although only the limestone of the Niagara Group appears in the surface out-crops in the county, we yet have a complete section of the underlying rocks, afforded by the artesian wells which have been bored in the city of Chicago and its immediate vicinity. Of the deepest and in other respects the most satisfactory for geological information, is the boring at the Union stockyards, southwest of the city, which passes through the strata from the upper portion of the Niagara Group to the Lower Magnesian Limestone. The whole depth penetrated was eleven hundred and five feet, and after about forty-six feet of drift and surface deposits, the strata were passed through in the following order:

NIAGARA GROUP, 254 FEET.

1. Bluish gray limestone.
2. Light gray limestone, slightly varying in color at different depths.
3. Limestone, nearly white. 50 feet
4. Limestone, buff or drab. 80 "

CINCINNATI GROUP, 250 FEET.

5. Shale, soft and fine. 104 "
6. Limestone, light gray. 20 "
7. Coarser and arenaceous. 126 "

TRENTON GROUP, 330 FEET.

8. Brownish ferruginous limestone. 25 "
9. Grayish limestone, more or less dark. 305 "

ST. PETER'S.

- | | |
|---|---------|
| 10. Whitish brown sandstone | 155 " |
| LOWER MAGNESIAN LIMESTONE, 70 FEET. | |
| 11. Light colored limestone, very hard..... | 60 feet |
| 12. Gray limestone..... | 10 " |

This last subdivision corresponds to the Calciferous Sandstone of the New York report. In Peoria, Tazewell, Grundy and adjoining counties the water-bearing rock is found in the Niagara, instead of the Lower Silurian; and still further south, where the Carboniferous formation is thicker, the necessary conditions may prevail to get artesian wells from the Carboniferous Group. This was a debatable question a few years ago in the Natural History Association of Illinois, of which the writer was a member. The question as to the northern part of the state was decided satisfactorily. While the province of Artois, in France, where the wells are abundant, and whence the name was derived, consists of Cretaceous strata, wells from other geological horizons might be cited. They depend no more upon any particular formation than do petroleum and natural gas. However, by studying the geological formation of any particular region, we may determine with some precision as to the depth at which water may be struck.

Artesian basins are commonly found in synclinal basins of sedimentary rock, and by getting the dip of the rock and finding where the exposed edges of the rock come to the surface on the rim of the basin—knowing these two facts the problem as to the depth is a simple one in trigonometry. From the great cost of sinking artesian wells in Wyoming, it is very evident that it is too expensive a method of water supply to sink wells for irrigation purposes. As a matter of interest, we call atten-

tion to two remarkable artesian basins to show what has been done by this method of irrigation.

SAN BERNARDINO BASIN, CALIFORNIA.

In the San Bernardino basin, California, 1,000 wells exist, whose depths average 200 feet. Some irrigate 100 to 200 acres, but this is exceptional. "It is quite evident that such an enormous quantity of water, from such shallow wells, makes the sinking of artesian wells for irrigation purposes practicable and very desirable."

SAN LUIS BASIN.

The following is from the Colorado Bulletin No. 16:

"The San Luis basin is the most remarkable of any yet developed in the state. Though here water was found by accident by S. P. Hoine as recently as the fall of 1887, while sinking a sand point for an ordinary drive well, the ease and cheapness of sinking have been such that there are now probably as many as 2,000. They are so numerous that the residents give no more than a passing glance to one, and as they are frequently sunk in less than half a day with the simplest of outfits, it is not remarkable that it is impossible to secure any kind of a complete list even of a limited locality. Wells are often sunk for \$25, and they range from this price upward, according to circumstances. In consequence it is cheaper to bore artesian wells than it is to attempt to dig wells of the ordinary kind, without the added inducement of the purer water. Hence within the limits of the flowing area nearly every occupied quarter section has a well, and sometimes more. The town of Monte Vista has 88; La Jara at least 17; S. E. Newcomb 8, and wells in corresponding numbers are found all over the valley." Other incidents might be

cited in the arid regions where the expense of boring, and the large flow of water, together with the favorable climatic conditions, change barren deserts into fertile regions. The most remarkable artesian well that I have seen is in Nevada, Vernon county, Missouri. It is not needed for irrigation purposes. The authorities have made two artificial lakes and laid out a park of 130 acres. It is known as the White Sulphur Springs and Lake Park, Nevada, Missouri. By excellent taste it has been made a charming and lovely resort, a beautiful and picturesque landscape. The well is 780 feet deep, and the water is forced by natural pressure up through an eight inch pipe, and overflows, forming a top like an umbrella, or like a weeping willow. It fills the two lakes, one of eight acres, the other three acres, varying in depth from four to seven feet. The water, besides being as pleasant to the taste as the various Sulphur Springs of New York, is very pleasant and invigorating for bathing purposes. There is probably enough water in that well to irrigate four or five sections of land in the arid regions. So then in answer to the question: "Whether it pays to sink artesian wells for irrigation purposes?" we would say that it depends, first, upon the cost of sinking the well, and second, upon the flow of water.

ARTESIAN WELLS OF SOUTHERN WYOMING.

The most remarkable wells of Wyoming are the two which have been sunk in Rawlins, Carbon county, during the past two years. They are half a mile east of the depot, on the south side of the railroad track. The first well was commenced in May, 1892, and was finished in October. Water was first struck at a depth of 305 feet, the second flow at a depth of 432 feet. The material through

which they passed for the first 220 feet consisted of a yellowish sand, containing alkali. The next 85 feet, a natural cement and gravel. Then 21 feet of blue limestone, beneath which was 100 feet of red ochre. Then came 6 feet of shale overlying a dark colored sand, in which was struck the main flow of water. Charles E. Blydenburgh informed me that a thin layer of magnesian limestone capped the water bearing rock ; he also thought that the red ochre was of the Triassic formation. The boring was continued in this stratum for thirty-five feet, making the total depth of the well 467 feet. There were 305 feet of 10 inch casing, within which were 430 feet of 5½ inch casing. The first flow was a small vein, and was cased off. The total cost was \$9 per foot for 467 feet, making \$4,203. The flow is 108,000 gallons per twenty-four hours ; and this flow has been constant from the beginning. Well No. 2 was sunk 60 feet northeast from No. 1. The big flow was struck November 2, 1893. The kind of rock for 220 feet was a yellowish sand rock, containing alkali. The next 80 feet was cement and gravel. Instead of the blue limestone at this depth in the other well there are five feet of shale, in which a small vein of water was struck. Then came about 100 feet of the red ochre ; then five or six feet of yellowish sandrock and about 22 feet more of the red ochre. At the depth of 426 feet they met with six feet of blue clay, then came the dark sand, at a depth of 36 feet in it water was struck, after which the boring was continued 18 feet, making a total depth of 486 feet. The cost of drilling, not counting the casing, was six dollars per foot. Although this well is but 60 feet away from the other, there is four times the flow of water, 432,000 gallons per twenty-four hours. Strange to say it has not affected the flow from the other well up to the

present writing, August, 1894. Both wells were drilled by W. W. Breese of Laramie. E. J. Fulton furnished most of the facts for the Rawlins wells. There is a 500 foot well at the court house in Rawlins. The water rose nearly to the top, and in pumping it sand would get into the pipe, hence the well was abandoned. Mr. McCutcheon informs me that R. M. Galbraith was the contractor, and at 475 feet it was a flowing well, but in going down the 500 feet he struck a crevice, and it ceased to be a flowing well. H. Rasmusson informed me that the total cost of well No. 2. was \$4,500, which added to the cost of well No. 1, \$4203, makes the total cost of the two wells \$8,703. The total flow of the water is 540,000 gallons every twenty-four hours. The temperature of the water on August 1st was 51 degrees, while that of the atmosphere was 77 degrees. The water of both wells flow together and is forced by steam power throughout the city. The question arose at once with me as to its source. In investigating the hills that enclose Rawlins on the north, west and south and observing the varied dip of the rock, I saw that the basin was too small to furnish such an immense supply of water. Fort Steele is 240 feet lower, and 15 miles east of Rawlins. The North Platte, one of the largest and most important water courses in the state, is thirty-five yards wide there, and has such a vast volume of water it would be reasonable to suppose that it percolated through the porous rock and produced the Rawlins artesian basin; but one of the conditions of an artesian supply is, that the source must be higher than the wells. Hence, if it be the North Platte, it must come from as far up as Saratoga, but Clarence King in his Geological Government Report describes an anticlinal fold between Saratoga and Rawlins, which prevents it coming from that way.

It is probable that it comes from hills or mountains over 7,000 feet high. It may be fifty miles away; sources have been traced much further than this. Herewith we give the analysis of well No. 1, as made by the Chemist, also the analysis of the mixture of the two as used in Rawlins:

Analysis of the water from artesian well No. 1, Rawlins.

Sample sent by Mayor Rasmusson.

	Grains per gallon.
Silica, Si O_2	.676
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.064
Lithium, Li	Trace
Potassium Chloride, K Cl	.886
Sodium Chloride, Na Cl	20.644
Magnesium Chloride, Mg Cl_2	.298
Magnesium Sulphate, Mg SO_4	7.225
Calcium Sulphate, Ca SO_4	23.799
Calcium Carbonate, Ca CO_3	.268

Total solids

By E. E. SLOSSON, Chemist.

Analysis of the mixture of the water of the two wells as now used in the City of Rawlins.

	Grains per gallon.
Silica, Si O_2	.57
Calcium Carbonate, Ca CO_3	8.88
Magnesium Carbonate, Mg CO_3	1.07
Sodium Chloride, Na Cl	26.82
Alkali	19.27

Total solids

By W. S. ROBINSON, U. P. R. R. Chemist, Omaha.

The following data of the Saratoga artesian well was furnished by J. F. Crawford of Carbon county :

Depth, 55 feet. It flows 50 palls per minute. The formation was sand and gravel for 12 feet, the rest was sandrock. It was sunk by Harris Bros., and cost about

\$100, and is situated on northwest quarter section 4, township 17, range 84 west, Carbon county. It flows freely and is a great success.

THE LARAMIE ARTESIAN BASIN.

There are several artesian wells in and about Laramie. The one on the State University campus was sunk by W. W. Breese in 1891. At my request he saved twenty-eight samples of the borings. The following is a description of them :

40 feet, fine quartz gravel and red sandstone.

80 feet, coarser and a little darker color.

120 feet, No apparent change.

160 feet, color the same, but a little more gravel.

200 feet, about the same as above.

240 feet, a little less gravel than the last two.

280 feet, considerably coarser and large fragments of gypsum.

310 feet, quite a change in color ; lighter red ; no grains of gravel or gypsum perceptible.

458 feet, fine light colored gravel and red sandstone, and some carbonate of lime, giving the whole a mottled appearance ; water was first struck at this depth.

465 feet, a slight change from the above ; hardly any gravel.

480 feet, lighter color than the above ; sandstone and carbonate of lime.

505 feet, coarser grain and darker color.

546 feet, a very decided change ; the borings almost an impalpable powder ; very much lighter color, a beautiful salmon tint ; some carbonate of lime.

570 feet, small chips of dark red sandstone and considerable light colored gravel, giving to the sample a mottled appearance.

595 feet, large chips of gypsum, and red sandstone ; (caving).

630 feet, red sandstone ; no gypsum or gravel.

657 feet, same color, containing a little gypsum.

698 feet, same as above.

733 feet, no apparent change.

825 feet, a remarkable change ; fine grain pinkish sandstone.

870 feet, same as above.

900 feet, very fine slightly tinted sandstone, and some limestone.

940 feet, very fine, lighter than the above; almost white sandstone and carbonate of lime.

970 feet, same as 940.

995 feet, same as above, except slightly reddish tint.

1015 feet, coarser grain, containing carbonate of lime, a light cream color.

There is such a slight difference in some of the samples above, color and fineness being the principal distinctions, that we give also a summary with more marked distinctions:

At 80 feet a change noticed in coarseness of material to 150 feet. From 150 to 300 feet finer and brownish red. From 300 to 560 much lighter colored and finer material, containing a little carbonate of lime; 560 to 590, mottled, coarser, darker, a little carbonate of lime; 590 to 615, coarse fragments of red sandstone and gypsum; 615 to 650, coarse brown sandstone; no gypsum; 650 to 680, coarse and a little gypsum; 680 to 780, medium in coarseness, brown sandstone; 780 to 880, very much lighter and very fine; 880 to 960, almost white, very fine sand and carbonate of lime; 960 to 1015, a little coarser than the above, having about the same amount of carbonate of lime, but a cream color.

There are 40 feet of 7½ inch casing to shut off gravel at the top, and 600 feet of 5½ inch casing. The first flow was struck at a depth of 458 feet; this comes up between the two casings. The second flow was struck at 820 feet. The drilling was continued to a depth of 1,015 feet. No more water was met with. The amount of water, as measured by Prof. B. C. Buffum, flowing at the beginning, was 50,000 gallons per twenty-four hours. The contract

price for drilling was \$2,000. The University furnished the casing at a cost of \$552.25; total \$2,552.25.

Partial Analysis of University Artesian Water.

	Grains per gallon.
Total residue on evaporation	12.130
Soluble in water after evaporation.....	6.392
Insoluble in water after evaporation.....	5.738
Silica, Si O ₂	.950
Iron and alumina.....	.630
Lime, Ca O.....	3.750
Magnesia, Mg O	2.105
Chlorine, Cl....	.799

By E. E. SLOSSON, Chemist.

Two or three miles east of the University I found an outcrop of the same sandstone in which water was struck in the artesian well. This rock dips under the red sandstone (the Triassic formation) at an angle of $6\frac{1}{2}$ degrees, and extends up the hills for three or four miles. I found in this formation the following genera of fossils: viz: Al-lorisma, Athyris, Bellerophon, Pinna, Productus, Myalina, besides others. These are sufficient to show that this formation belongs to the Carboniferous age. It dips under the Triassic, which is the surface rock at the University, and from the borings seems to be about 825 feet thick. It thins out rapidly towards the hills and the Carboniferous becomes the surface rock, in some places, one and a half miles away. Since it has been maintained by pretty good authorities that the City springs and the artesian wells at Laramie are supplied with water by the Snowy Range which is forty miles distant, I desire to present a few facts here to show that the water does not come from that source, but from the hills to the east. In the first place it is shown by the borings from the artesian

well at the University that the surface rock not far from the springs is identical with the water-bearing rock struck at the University artesian well. The pressure in the well is about the same as the altitude of the outcrop to the east would indicate.

Secondly, if the springs and artesian well derived their sources of water from the Snowy Range they would hold in solution some of the minerals found there, which they do not.

Thirdly, since water tends to seek a level, the pressure would be many times as great as it is, for the Snowy Range is about 4,000 feet higher than the well, while the altitude of the water bearing rock to the east gives about the pressure as measured at the well.

Furthermore, if the Snowy Range were the source, we would expect a better supply and strong flowing artesian wells west of the Laramie river and nearer the source of supply. Many attempts have been made to get artesian water a few miles west of the river but without success. I am informed by W. W. Breese, who has sunk several wells there, that the red rock has never been struck. It must be that there is quite a break, or fault, in the Triassic, also in the underlying Carboniferous formation just east of the river, which would throw them a great depth below the surface, even a short distance west of the river. The average dip of the first lime outcrop of rock, about 2,600 yards east of the University and 80 to 100 feet higher altitude, is $6\frac{1}{2}$ degrees. The dip of the sandstone under this, further up the hill, is the same. Working from the above data, the depth would be close to that at which water was struck, 825 feet.

In answer to one objection made to the supply of

water coming from the hills east of town, viz.: that there is not rainfall sufficient to produce the springs and wells, I would say that this is an assertion without proof. The average annual rainfall for several years taken at Fort Sanders, just south of the city limits, is 13 inches. The rainfall on the hills to the east is greater than this, probably 15 inches or more, and there being such a vast extent of the water-absorbing sandstone exposed on the hillsides, make the conditions in and about Laramie to the east of the river very favorable for artesian water; and it would be much better but for so much water coming to the surface at the City springs, Soldier springs, and the springs at the Jabez Simpson ranch. All these are within a distance of seven miles. These three groups of springs yield at least three million gallons every twenty-four hours; some estimate it much more. There are gullies and dry branches on the hillsides which sometimes become turbulent streams. A little computation will show that twenty or more square miles of porous sandstone, with fifteen inches rainfall coming in contact with it yearly, would furnish as vast a water basin as is exhibited by the springs and wells.

A few words in regard to the snowy range water supply will not be out of place here. The limpid streams that make the Centennial valley so beautiful and luxuriant come from the dripping snows of the mountains fifteen miles distant. Some come gurgling and murmuring through canyons of their own chiseling, those deep-cut furrows in the mountain sides. Others originate in immense springs that break forth from underneath the mountains. We call attention to a notable one owned by J. J. Hays. We estimate that fifty feet away from the spring

the stream is two feet deep and five feet wide, moving with a considerable velocity, it being the main branch of the Middle Fork of the Little Laramie river. Properly managed it would irrigate several sections of hay land. This is but a small fractional part of the water that flows out of the Centennial valley through the Little Laramie river, the great outlet of the melting snows of the mountains.

We quote herewith from the Senate Executive Documents, first session Fifty-second Congress, 1891-1892, Vol. IV., Irrigation. This is from the final report of the artesian and underflow investigation and of the irrigation inquiry in pursuance of authority conferred by Congress in 1890 and 1891. Referring to Wyoming:

"There are eighteen artesian wells in the territory, sixteen of them being located at and near Laramie City, one at Cheyenne and one at Rollins." [This should be Rawlins, and refers to the one at the court house.] "There are also a small number of bored wells in the neighborhood of Laramie in which the water rises not quite to the surface and is raised by means of windmills. The water of these wells is used entirely for domestic and stock purposes."

I have visited nearly all the artesian and bored wells on the Laramie Plains, and have given a detailed account of them, so far as I was able to get the data. The deepest and most important well in Albany county is the county well sunk in 1887 in the northern part of the City of Laramie and about three-quarters of a mile in a bee-line northwest from the University well, and on 39 feet lower ground, measured especially for this Bulletin, free of charge, by the City engineer, W. O. Owen. It being on

such low ground, it is impossible to conduct it anywhere, except at a very great expense. The object of sinking this well was to get oil.

A friend of mine, E. G. Gay, of New York, who sunk the oil wells at Bowling Green, Ohio, visited me during this time, and on going down to see the well he remarked that in nine cases out of ten people in boring for oil or gas sought the lowest ground. "What a mistake," said he; "if they only get water it cannot be conveyed anywhere." He made a practice of boring on higher ground and was very successful, being the first one that struck gas in one of those celebrated Ohio regions. He pointed to the grounds of the University as being more suitable prospect grounds, remarking that if only a good flow of water should be struck it could be utilized at a small expense. The two Rawlins wells are also on the lowest grounds in the city.

The county well was sunk by the Nebraska, Colorado and Wyoming Oil and Mining company of Sidney, Nebraska, Edward Elmer in charge. The following is my description of the borings saved by George W. Fox, then county clerk. These samples are at the court house. There were no samples kept until at a depth of 730 feet.

730-927 feet, red sand rock.

927-1000 feet, a decided change, a very fine, almost white sandstone.

1000-1015 feet, pinkish colored sandstone.

1015-1030 feet, yellowish fine-grained sandstone.

1030-1090 feet, white sandstone and carbonate of lime.

1090-1195 feet, salmon colored sandstone and carbonate of lime.

1195-1200 feet, a cream color; marked magnetic; oil, and sand.

1200-1215 feet, lime rock below the oil rock; red sandstone, marked highly magnetic.

1215-1225 feet, red sandstone, over 1,200 feet deep.

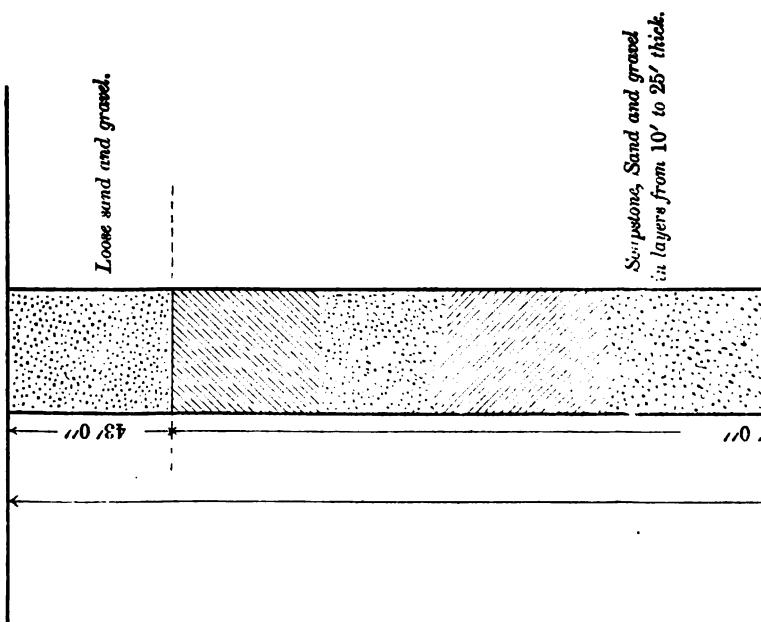
- 1225-1235 feet, coarser grain, and deeper red color.
- 1235-1245 feet, coarse, white and red, mottled.
- 1245-1315 feet, very fine even grain, and pinkish color.
- 1315-1325 feet, same as above.
- 1325-1355 feet, a tawny or light snuff colored sandrock.
- 1355-1370 feet, much coarser grain, and white quartz sand.
- 1370-1400 feet, light red, even grained sandstone.
- 1400-1415 feet, about an equal amount of red and white sand.
- 1415-1440 feet, a lighter color, containing small fragments.
- 1440-1450 feet, a little finer and deeper in color.
- 1450-1456 feet, a remarkable change, an exceedingly fine grained, white quartz sand.
- 1456-1470 feet, coarser grain, and of a reddish color.

Those in charge of sinking the well marked some of the samples magnetic, and created considerable excitement at the time by reporting to the papers that they had struck magnetic water. This is an impossibility. It is a very common thing to have the drills, by their continual pounding and friction, become strong magnets, and such they happened to be at the depth of 1,200 feet in this well. Several flows of water were met with, but the big one was struck at the depth of 987 feet. All the other flows were piped off, since this alone made about a four inch solid stream. Experiments were tried, and water was thrown twenty feet through a one inch hole. The boring was continued for 516 feet further, but no more water was found. There were 735 feet of 6½ inch casing, and 400 feet of 9 inch casing. The temperature of the water on August 27, was 48 degrees, while the atmosphere was 81 degrees. The contract price was \$7,500 dollars.

I am indebted to J. J. McCutcheon for most of the facts concerning this well, also the data for the large number he drilled.

There is a first class flowing well on Judson, S. W. 1/4, T. 1 N., R. 10 E., S. 10 E.

FORMATION
Judson, Sutphin & Co.'s Artesian Well.



the red rock. There was but a feeble now at first. The water stands now within six inches of the top. A long stick had been left in it and was colored as black as

1025-1225 feet, coarser grain, and

I am indebted to J. J. McCutcheon for most of the facts concerning this well, also the data for the large number he drilled.

There is a first-class flowing well on Judson, Sutphin, and Co's. Dutton Creek ranch. It was sunk by Breese & McKefair in 1889. They went through 24 feet of coal. The well is 540 feet deep and there is still an excellent flow of water. It is supplied from the mountains to the west, and is a splendid prospect, not only for the large flow of water, but also for the discovery of such vast veins of coal. We are quite fortunate to be able to show a cut of the formation through which they passed in sinking this well. Three separate veins of coal were struck, each eight feet in thickness. The cut was made from the drawings of C. E. Judson, of Chicago, president and engineer of the Gas Company of Chicago. We also insert the following quotation from him:

"These veins of coal undoubtedly underlie the whole of sections 22, 26, 28 and 32, of the Dutton Creek ranch, township 19, range 77 west."

Just east of the city on the Charley George ranch, now occupied by N. E. Stark, there are six artesian wells. Mr. McCutcheon sunk three of them. He drilled in one over 90 feet through limestone and struck water in sandrock. He used 5½ inch pipe but there was only one inch flow at first. It now stands eighteen inches from the top of the pipe. This ranch takes in all of section 3, township 15, range 73 west, and is platted as East Laramie. At and near the fair grounds, on the south side of the above named ranch, and part of it, about one mile from the city limits, he sunk two wells in 1888. The one within the fair grounds is 120 feet deep, and did not pass through the red rock. There was but a feeble flow at first. The water stands now within six inches of the top. A long stick had been left in it and was colored as black as

ink by the sulphur in the water. This well was the only one of the group that had an odor of sulphur. The temperature was 56 degrees.

The big flowing well is situated just outside the grounds, and is 140 feet deep, and at first boiled eight and one-half inches above the $5\frac{1}{8}$ inch pipe. It is about as strong as ever. I investigated all of these wells in company with N. E. Stark, on August 18, 1894. A circle described with a radius of a quarter of a mile would enclose all of these wells. The one at the house is pumped by a windmill. The temperature of the water was 46 degrees and that of the air, in the sunshine, was 90 degrees. Two others were about 175 yards from the house. In one the water stood within two feet of the top of the pipe. This well is less than 200 feet deep, all red rock, and in the other, 30 yards distant, and eight feet higher ground, water stood about six feet from the top. This is the deepest of the group, 312 feet, all limestone. The temperature of these two was 58 degrees, while the sun was shining against the top of the pipes, with a temperature of 90 degrees. In the spring time the lower of these two wells becomes a flowing well. The three wells were drilled by Breese & Cokefair, in 1888. Mr. Stark informed me that, if the big flowing well were plugged, the one within the fair grounds, being nearest to it, would flow within three hours. The experiment had been tried, and I believe that if both were plugged, those at the house, a half a mile away, would flow. We purposed taking the temperature of the big flow, but could not approach it within twenty feet. It was boiling up a foot or more above the pipe and produced a large reservoir. It was partially plugged, and would boil nearly as high if it were

not. The remaining well is in the northeast corner of the stock barn, near the house. Water stood within three feet of the top of the pipe. The temperature was 54 degrees, that of the air was 74. This well was drilled by J. J. McCutcheon, and was at first a flowing well, but there was so much ice around it in the winter, that Mr. George cut it off, and in the spring when he removed the plug, it ceased to be a flowing well. I attribute this to the fact that the supply is from a secondary basin, having quite a limited surface drainage, and the big flow is a sufficient vent for all the water in the water-bearing stratum except in the spring of the year, when there is more abundant snow and rain.

We call attention to a few facts pertaining to the supply of water in the vicinity of the fair grounds: The City springs are situated in southeast quarter, section 35, township 16, range 73 west, in a beeline south in southeast quarter, section 23, township 15, range 73 west, the Soldier springs break forth in their crystalline beauty, and exactly south in section 2, township 14, range 73 west, is the ranch of Jabez Simpson, noted for its excellent springs. All these are within a distance of seven miles.

In the southeast part of section 14, about a mile north of Soldier springs, is a spring five feet below the surface, coming from a dark red sandstone, so mixed with lime, that it seems to be a connecting link between the Triassic and Carboniferous formations. The temperature on August 22, was 52 degrees and the air was 75 degrees. The water is quite soft. Five years ago this spring made a pond 50 by 100 yards, giving source to quite a large running stream. There is an exceedingly interesting cave about half way on a north and southeast line between

the spring and Mr. Pelton's house. It was formed nine years ago. A subterranean flow of water was the cause. Although there is no water in sight, we are quite certain that it was thus produced. It is about fifteen feet across the top and fifteen feet deep. It is a perfectly dry red rock formation, but the most venturesome person would hesitate to go down into it without clinging to a strong rope. The sides are almost perpendicular. It is probable that this caving dammed up the underground current and forced it out above, forming the spring mentioned. Five years ago there was a lake on the northeast quarter of section 14, over a mile southeast of the fair grounds. It was between two and three hundred yards in diameter. But this lake dried up, and the stream flowing from the above mentioned spring was lost at the same time; and has found its old underflow or another one. These facts substantiate the proposition laid down, when speaking of the wells on the George ranch. It is very probable that water can be struck at a depth of 160 feet, anywhere east of the railroad, and within four or five miles south of the city, but many more wells in the vicinity of the flowing ones, would undoubtedly stop their flow. Scores of wells could be sunk that windmills could not exhaust.

Clark W. Pelton has two wells on his ranch, in the southwest quarter of section 10, township 15, range 73 west. The first was sunk in August, 1889, and is 333 feet deep; the rock passed through was all red rock, with an occasional seam of gypsum; sunk by Breese & Cokefair. It cost \$1.50 per foot for the first 200 feet, and \$2 for the balance. Total cost of drilling was \$566. Mr. Pelton furnished the 5½ casing. At a depth of 120 feet they struck a vein of water, which rose to within 60 feet of the

top, but gradually increased as they went down, to within seven feet of the top of the pipe. Quick sand was struck at a depth of 333 feet. This is an excellent quality of water. The temperature on August 22, was 47 degrees; the air was 72.

We give herewith an analysis of the water, as made by the chemist of the station:

Partial Analysis of Water from Pelton's Artesian Well.

Water highly impregnated with hydrogen sulphide, H_2S .

Grains per gallon.

Total residue on evaporation.....	60.053
Silica, SiO_2	1.498
Iron and alumina.....	.081
Lime, CaO	15.512
Magnesia, MgO	6.181
Sulphuric acid, SO_3	18.375

By E. E. SLOSSON, Chemist.

The chemist intends in the near future to issue a bulletin on the analyses of the water of the artesian wells, also of irrigation water. Time would not permit of any more analyses for this bulletin.

Mr. Pelton has two tanks, one 24 feet long by 4 feet wide and 2 feet deep; the other is 8 feet long, 3 feet wide and 3 feet deep, capacity 264 cubic feet, and hold nearly 1,500 gallons. By pumping these full, and allowing it to stand it becomes sufficiently warm for irrigation. Mr. Pelton has a garden of about one acre irrigated by this well. Two hundred yards to the north and across the road in the pasture is another well, sunk this year. The water stands to within thirty inches of the top of the eight inch pipe. The formation is all red rock. This well being on a rise of ground, a small ditch is dug nearly three feet deep, leading to an artificial pond, hence this negative well is converted into a feebly flowing well. The

temperature was 52 degrees on ' August 22, while the atmosphere was 72 degrees.

Mr. Homer's well, given in the table, is the furthest from the hills of any sunk in this basin, and since the rock becomes thicker as the distance from the hills increases, it is a question as to the depth at which flowing water could be struck. If we were certain that the dip does not change, it could be figured out satisfactorily. The angle between the University and the county well is some less than the dip of the rock on the hills to the east. It is very probable that it is so on Mr. Homer's ranch. I

Tabulated Description of Wells on the

OWNER	DRILLED BY	Depth, Feet.	LOCATION.
S. W. Downey, Laramie.....	W. W. Breese.....	166	Sherrod's Addition, Laramie
O. D. Downey, ".....	G. B. Bariana.....	170	Sec. 4, Tp. 15, Rg. 73 W., Albany Co.
" " ".....	J. J. McCutcheon.....	531	" " " " "
S. W. Downey, ".....	" " ".....	380	Sec. 1 or 12, Tp. 18, Rg. 78 W., Carbon Co.
Oxford Ranch, Red Buttes.....	" " ".....	540	" " " " "
" " " " ".....	" " ".....	350	" " " " "
S. W. Downey.....	" " ".....	160	Tp. 13, Rg. 73 W.
Geo. H. Hunt, Laramie.....	Ryan Bros.....	65	Sec. 10, Tp. 15, Rg. 73 W.
" " " " ".....	" " ".....	220	" " " " "
Thomas McHugh.....	G. B. Bariana.....	112	NE $\frac{1}{4}$ Sec. 5, Tp. 15, Rg. 73 W.
" " ".....	Ryan Bros.....	117	NE $\frac{1}{4}$ Sec. 8, Tp. 15, Rg. 73 W.
*Jabez Simpson.....	G. B. Bariana.....	112	SE $\frac{1}{4}$ Sec. 5, Tp. 15, Rg. 73 W.
Peter Hanson.....	" " ".....	86	NW $\frac{1}{4}$ Sec. 8, Tp. 15, Rg. 73 W.
Robert H. Homer.....	W. W. Breese.....	1118	Soc. 12, Tp. 14, Rg. 74 W.
Laramie Cemetery.....	Breese & Cokefair.....	800	" " " " "
George Montague, Laramie.....	" " ".....	150	Northern part of Laramie
J. S. Braskett.....	" " ".....	225	Downey Addition
" " " " ".....	" " ".....	100	" " " " "
A. T. Holmes.....	" " ".....	"	" " " " "
Judson, Sutphin & Co.....	" " ".....	"	" " " " "
W. H. Holliday Co., Laramie.....	G. B. Bariana.....	80	Sec. 6, Tp. 15, Rg. 74 W.
Ryan Bros.....	Ryan Bros.....	85	Northern part of Laramie

*First well sunk in the State.

believe that he could have a flowing well at a depth of 1,500 feet. At any rate such a depth would be of great public interest, as it would show whether water can be had at that depth, and in what quantities, and it would prove whether there is any oil or gas in that distance. Mr. Homer says he would have gone down to that depth had the machinery been suitable.

We have spoken of attempts to get artesian wells west of the big Laramie river. We think that the following description from our various data will be instructive and quite appropriate: Oliver Mansfield, living on sec-

Laramie Plains, not given elsewhere.

Time.	Feet of Casing	Formation.	Temperature of water in summer.	Flow per 24 hours.	Cost of Drilling.
1887		Red rock.	45°	3927 gallons	.....
1882				At first 1-inch pipe; now negative	.....
1886			45°	8640 gallons	.....
1889				Negative well	.....
1886		11-foot vein of coal at 313 ft.	.....	Filled a 5 inch pipe	.....
1889		Gray sandrock	.....	Filled a 2-inch pipe	.....
.....				Being on high ground, a deep ditch made it flow.	.....
1891				Good flow	.....
.....				Negative; water 18 inches from top. The windmill sometimes pumps it dry.	.....
1892				Negative; water 18 inches from top. The windmill does not affect amount	.....
1887 37			45°, air 77°	1080 gallons	\$ 155 50
1891			44°, air 76°	831 "	163 80
1879			46°, air 82°	864 "	.....
1891 1080		Red rock.	46°, air 80°	Negative well	.....
.....				Negative; water 4 feet from top. The windmill does not lower it.	.....
1886				2-inch pipe	.....
1886		Red rock.	.....	Negative; water 6 feet from top	.....
1886		" "		1-inch pipe flow	.....
1889		" "		Small flow	.....
1890		" "		Small flow	.....
.....				Negative; water 9 feet from top	.....
.....				Negative well	.....
.....			46°	840 gallons	.....
.....					

1896 00
Casing \$900

tion 20, township 14, range 75, sixteen miles southwest of the city, and one mile west of the Big Laramie river, commenced to bore a well in 1890. The first nine feet they passed through gravel, then struck a dark shale. At the depth of 65 feet a small stream of very salt water was met with, and a little further down the water had a very strong petroleum odor, and at 245 feet gas was struck. I visited the well; we plugged it with a block, boring a half inch hole through it, and lighted the gas, which produced a three or four inch flame that continued to burn for several hours. They tried the experiment two or three different ways, with the same result.

At a depth of 440 feet salt water raised to within four feet of the top of the pipe. The drilling was continued to a depth of 502 feet, making 493 feet of shale. It was impossible to tell how much thicker it was. The work was stopped on account of the great expense of sinking. The work was done by W. W. Breese.

We herewith quote from the Senate Report on Irrigation, and from the data therein given will work out the problem as to how much land the University well would irrigate, under proper management, trusting that it will be of some practical utility:

"B. S. La Grange, irrigation expert, estimates that: "In Colorado the flow of a cubic foot per second, throughout the irrigation season, is sufficient for about 100 acres; but with the constant flow from an artesian well, the duty of water in experienced hands will be much greater; it is safe to say 200 acres per second foot." He says further, "That in Colorado, it costs to bring water to one's land, from the streams, \$3 to \$5 per acre. In Dakota, the constant flow will allow each cubic foot per

second to supply 200 acres, under good management. If a well flowing six cubic feet per second can be put down for \$2,500, it is less than it is with us, where we bring our water from the streams in ditches."

The flow from the University well was at first, 50,000 gallons in twenty-four hours, or $2,083\frac{1}{3}$ gallons in one hour. Dividing this by 3,600, the number of seconds in an hour, it gives the decimal, .5787 of a gallon per second. There are, approximately, $5\frac{1}{2}$ gallons in a foot. Divide this last decimal by $5\frac{1}{2}$, and we get the decimal, .10522 of a cubic foot that the well flows in a second. If one cubic foot per second will irrigate 200 acres in Dakota, this decimal part of a cubic foot will irrigate such a part of 200 acres, which is 21 acres; but we believe that this estimate is too high for Wyoming, where the soil is usually more gravelly and porous, and containing less clay, and the evaporation, due to elevation; being greater, we would deduct at least $33\frac{1}{3}$ per cent, some say more. This would give a result of 14 acres. But in order to do this a reservoir would have to be built to store the water.

Corthell and Bevans had one sunk by J. J. McCutcheon in 1889, about one mile north of the cemetery, on the bottom lands. The formation was red rock and full of seams. They went down 313 feet and got a flowing well.

There is a well at the hospital, in the eastern portion of the city limits, something less than 200 feet deep; drilled by G. B. Bariana. At first it was a flowing well, but after a time it sunk down 40 feet or more.

McCutcheon & Cokefair put down a well for Ora Haley, on the Oasis ranch, near Wyoming station, in 1892. Water kept rising in the pipe as they went down, and at the depth of 89 feet it stood eighteen inches from the top.

It is probable that at 30 feet more, they would have had a flowing well. I call it a negative artesian well.

There are several shallow wells, about 28 to 30 feet deep, on the Sartoris Willan Home ranch, on a branch of the Little Laramie river. There is one of such excellent quality of water, and being a negative well, it deserves special mention. It is 500 feet deep, and water rises within four feet of the top, and being on ground 25 feet higher than where the barns are, a ditch could be sunk so as to convey the water to the barns, in which case this would be a flowing or a positive artesian well. I class it now as a negative artesian well. A windmill does not exhaust it. Geo. Morgan furnished the facts for the above description.

The W. H. Holliday Co., had a well sunk in the northern part of the Sherrod addition to Laramie, about a half a mile nearer the center of the city than the flowing well already described, in the same addition. They went down 189 feet, and it was quite a disappointment that they did not get an artesian well, since there are several within a mile. There was some mismanagement in handling the casing, etc. It illustrates that there is some uncertainty of getting water, even in a well known artesian basin.

We find in the September number of the *American Agriculturist*, the following fact, which is of sufficient interest for insertion here:

"Of late years many of the market gardens near Salt Lake City are irrigated from artesian wells, which have an average discharge of 26 gallons per minute. In 1890 there were 2,000 of these drive-wells in the territory, some

of which have a volume sufficient to irrigate five to seven acres."

Frequent mention has been made in this bulletin of artesian wells ceasing to flow. Oftentimes the pipes become obstructed by sand or gravel or other material getting in and choking up the pipes until the flow ceases. In such cases one would be led to believe that the sources of supply had failed. But in artesian regions, we often hear of pipes being cleaned, and the flow restored. We must distinguish between the choking up of a well and of the supply being actually cut off by too many wells being in close proximity.

Official Analyses of Union Pacific Railway Wells.

After collecting the material for the information thus far given in this bulletin, I interviewed Col. S. W. Downey, who has had more artesian wells sunk than any other individual in the state. He at once dictated a letter to E. Dickinson, general manager of the Union Pacific Railway Company, who by correspondence with the various departments, has enabled us to present the following, concerning the wells sunk by the Union Pacific Railway Company in Wyoming.

We are under special obligations to T. A. Davies, division master mechanic, for particular facts furnished by him and for having the data type-written for the publishers.

OMAHA, Nebr., August 24, 1894.

Mr. J. H. McConnell, Superintendent of Machinery:

DEAR SIR:—Enclosed please find analyses of water from different artesian wells in Wyoming. I have put on each analysis all the information which there is in this office.

In regard to the formation through which the drill passed, I should think Mr. Davies, at Laramie might possibly have a record. No record of the flow is ever sent here.

Yours truly,

W. S. ROBINSON, Chemist.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., April 26, 1893.

Sample of water from Rawlins, Wyo., received April 14th, 1893, from well No. 1; drilled in 1883, 402 feet deep; cased 300 feet.

One gallon contains in solution :

	Grains.
Silica.....	0.93
Carbonate of lime.....	8.14
Carbonate of magnesia.....	0.97
Sulphate of lime.....	5.53
Sulphate of magnesia.....	7.13
Sulphate of soda.....	6.33
Chloride of soda.....	12.48

Total solids.....41.51

In September, 1888, the total solids of this well were 24.3 grains per gallon.

W. S. ROBINSON, Chemist

Well No.1, at Rawlins, drilled through 20 feet of soil. From 20 to 310 feet, chalk rock. From 310 to 350 feet, hard conglomerate rock. Water is found in conglomerate rock and gravel of smooth, round and oval worn pebbles. Depth of well, 360 feet.

Well No. 2, same conditions of rock. Wells are only 25 feet apart. Well No. 2 furnishes 4,000 gallons per hour.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., November 15th, 1893.

Sample of water received November 13th, 1893, from Rawlins, Wyoming. New City well, 471 feet deep. This well flows 18,000 gallons per hour through a 6 $\frac{3}{8}$ inch casing.

One gallon contains in solution :

	Grains.
Carbonates of lime and magnesia.....	14.20
Sulphates of lime, magnesia and soda.....	24.06
Chloride of soda.....	19.40

Total solids.....57.66

W. S. ROBINSON, Chemist.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., October 31, 1888.

Sample of water, artesian well, received September 28, 1888, from
Rawlins, Wyoming.

One gallon contains in solution :

	Grains.
Carbonate of lime.....	7.51
Carbonate of magnesia.....	0.86
Sulphate of lime.....	1.00
Sulphate of magnesia.....	4.34
Silica.....	0.54
Alumina.....	0.09
Sulphate of soda.....	2.56
Carbonate of soda.....	0.28
Chloride of soda.....	7.06

Total solids.....24.34

This well (No. 1) is 402 feet deep and cased for 330 feet.

H. B. HODGES,

Chemist and Engineer of Tests.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., May 2, 1892.

Sample of water, artesian well, received April 27th, 1892, from
Bitter Creek, Wyoming.

One gallon contains in solution :

	Grains.
Silica.....	0.23
Carbonate of lime.....	0.77
Sulphate of soda.....	25.05
Carbonate of soda.....	48.90
Chloride of soda.....	5.59
Silicate of soda.....	0.50

Total solids.....81.04

This well is cased for 639 feet.

W. S. ROBINSON, Chemist.

BITTER CREEK.—This well has a capacity of 33 gallons per minute natural flow at surface, and has a head pressure of 23 pounds per square inch at surface. By pumping, well will furnish 2,000 gallons per hour. There is 69 feet surface deposit or soil, then 12 feet shale rock and small vein of coal. From 80 feet to 580 feet the formation is black shale, with small vein of sand rock from 580 feet to 586 feet, with shale again to 680 feet, when sand rock is struck, which furnishes water for present flow. Continued down to 1250 feet through shale, where a thin streak of sand rock gave another flow of 3 gallons per minute. This well has 560 feet of 7 ½-inch casing.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., May 5, 1892.

Sample of water, artesian well, received April 25, 1892, from Red Desert, Wyoming.

One gallon contains in solution :

	Grains.
Silica	0.06
Carbonate of lime	4.13
Carbonate of magnesia	2.40
Sulphate of Magnesia	1.51
Sulphate of soda	68.25
Chloride of soda	2.38
Carbonate of soda	11.97

Total solids 90.70

This well is cased for 515 feet.

W. S. ROBINSON, Chemist.

Red Desert No. 2, drilled in 1882, depth 763 feet, cased 515 feet with 5 ½-inch casing. Soil drilled through about the same as Bitter Creek. Is pumped at a depth of 300 feet from surface with 3 ½-inch tubing and 3 ¼-inch pump barrel. Produces 1000 gallons per hour.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., August 2, 1889.

Sample of water, artesian well, received July 30, 1889, from Carbon, Wyoming, from bottom of well 325 feet deep.

One gallon contains in solution :

	Grains.
Clay	1.17
Carbonate of lime	13.56
Sulphate of lime	1.70
Carbonate of magnesia	1.50
Sulphate of Magnesia	11.37
Sulphate of soda	25.94
Chloride of soda	1.48

Total solids 56.72

In July, 1890, this well had reached a depth of 735 feet and contained 123 grains of mineral matter in solution. The well is not used by the company.

H. B. HODGES,

Chemist and Engineer of Tests.

This well was drilled in sand rock the entire depth, with an occasional vein of shale two or three feet thick. Drilled to 743 feet deep, with 673 feet of 5 $\frac{3}{8}$ -inch casing.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., May 7, 1892.

Sample of water, artesian well, received April 27, 1892, from Fillmore, Wyoming. This well is 1353 feet deep, cased 882 feet with 5 $\frac{3}{8}$ -inch casing.

One gallon contains in solution :

	Grains.
Silica	0.32
Carbonate of lime	2.31
Carbonate of Magnesia	1.51
Sulphate of soda	24.35
Chloride of soda	2.98
Carbonate of soda	22.92

Total solids 54.39

W. S. ROBINSON, Chemist.

REPORT OF CHEMICAL TEST.

OMAHA, Neb., January 5th, 1889.

Sample of water received December 13th, 1888, from Harpers, Wyoming. Well 450 feet deep; drilled in 1882; pump 225 feet below surface. Water has been found by experience to be corrosive when cold, and to foam in the boilers. Drilled 425 feet, with 293 feet of 5 3/8 inch casing.

One gallon contains in solution :

	Grains.
Carbonate of lime.....	3.23
Carbonate of magnesia.....	1.06
Clay.....	0.39
Chloride of soda.....	1.95
Sulphate of soda.....	49.70
Bicarbonate of soda.....	5.14

Total solids.....61.47

H. B. HODGES, Chemist and Engineer of Tests.

REPORT OF CHEMICAL TEST.

OMAHA, Nebr., May 14th, 1889.

Sample of water, new well, received May 10th, 1889, from Wamsutter, Wyoming. Artesian well cased 500 feet.

One gallon contains in solution :

	Grains
Carbonate of lime.....	3.13
Chloride of soda.....	2.30
Sulphate of soda.....	54.53

Total solids....59.96

H. B. HODGES,

Chemist and Engineer of Tests.

Wamsutter well No. 2, drilled 725 feet, cased 500 feet with 5 3/8 casing. Will furnish 3,750 gallons per hour.

Wamsutter well No. 3, formation as follows :

140 feet soil or surface deposit.

140 to 160 feet, brown sandstone, very soft.

160 to 165 feet, small vein of coal.

- 165 to 200 feet, light colored shale.
- 200 to 201 feet, very hard streak, brown sandrock.
- 201 to 215 feet, light colored shale.
- 215 to 235 feet, cream colored chalk rock and soapstone.
- 235 to 240 feet, vein of coal.
- 240 to 258 feet, light gray colored shale.
- 258 to 259 feet, hard streak of rock.
- 259 to 270 feet, soft chalklike rock.
- 270 to 271 feet, small vein of coal.
- 271 to 280 feet, light gray material.
- 280 to 282 feet, very hard rock.
- 282 to 340 feet, light gray shale.
- 340 to 345 feet, dark brown rock.
- 345 to 350 feet, vein of coal.
- 350 to 360 feet, dark brown rock.
- 360 to 420 feet, light gray shale, somewhat gritty.
- 420 to 435 feet, dark brown colored rock, hard and tough to drill.
- 435 to 450 feet, vein of coal.
- 450 to 485 feet, brown sand rock.
- 485 to 490 feet, vein of coal.
- 490 feet to bottom of well, shale.

This well has in 650 feet of 8-inch casing. Water vein at 700 feet to 715 feet, and is pumped with a deep well pump. Will furnish 4,500 gallons of water per hour.



FIFTH ANNUAL REPORT

--OF THE--

AGRICULTURAL COLLEGE

--OF THE--

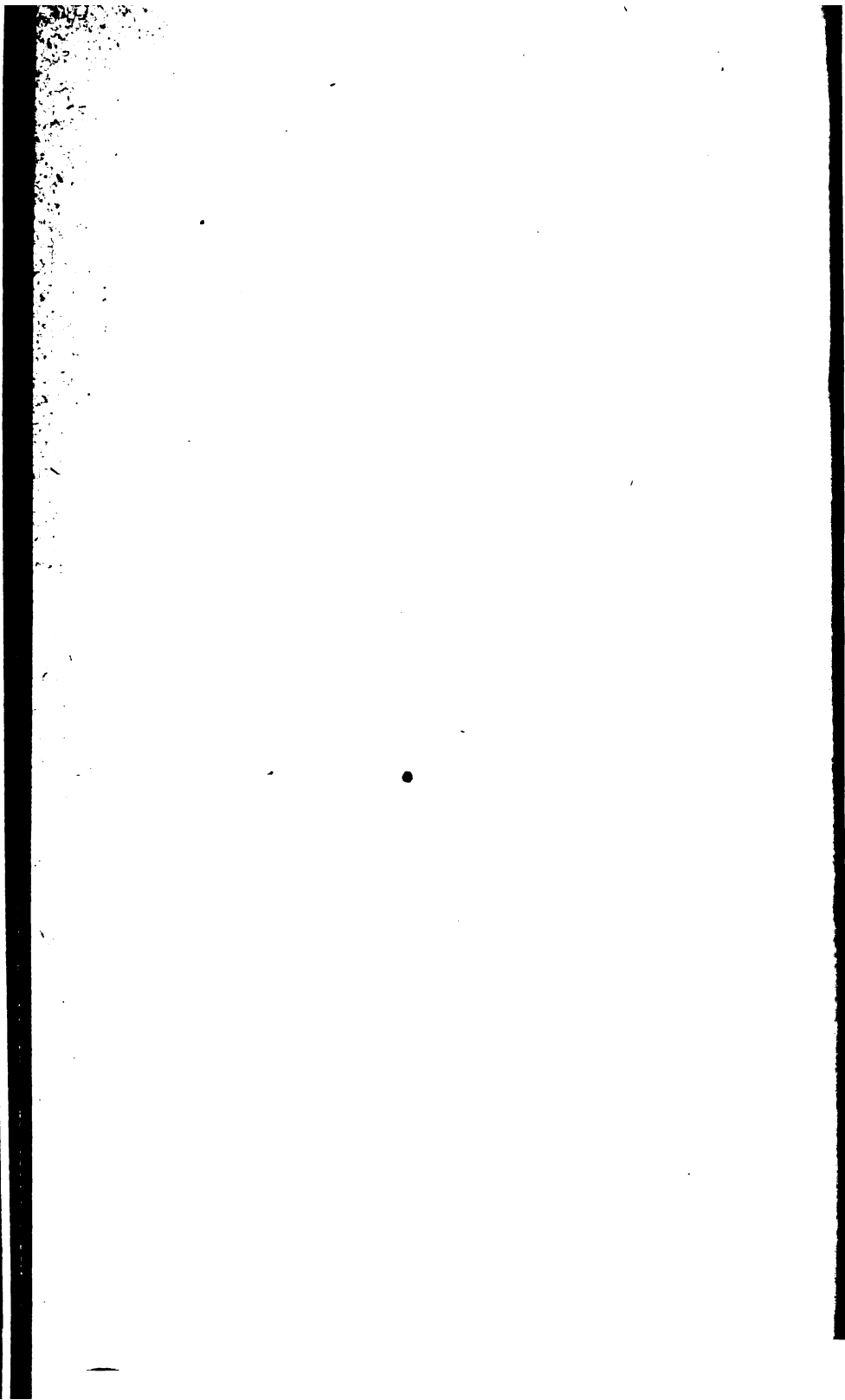
University of Wyoming

--AND THE--

AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR 1895.

CHEYENNE, WYO.
THE S. A. BRISTOL CO., PRINTERS & BINDERS,
1895.



LETTER OF TRANSMITTAL.

HON. WM. A. RICHARDS,
GOVERNOR OF WYOMING,
Cheyenne, Wyoming.

SIR:

I have the honor to submit herewith the Fifth Annual Report of the Agricultural College of the University of Wyoming, and the Agricultural Experiment Station connected therewith, for the year 1895.

The report will be sent to all similar colleges, the Honorable Secretary of the Interior, and also to the Honorable Secretary of Agriculture, as required by Congressional enactment.

Very respectfully,



President.

UNIVERSITY OF WYOMING,
January 2, 1896.

UNIVERSITY OF WYOMING.

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COLLEGE OF AGRICULTURE.

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CHARLES A. VARNUM, Captain Seventh Cavalry, U. S. A. Professor of Military Science and Tactics.

FIFTH ANNUAL REPORT
OF THE
Agricultural College of the University of Wyoming
FOR THE YEAR 1895.

I have the honor to submit my fifth annual report of the Agricultural College, which is one of the schools of the University of Wyoming, as provided in Section 2 of the Act of Incorporation of the University of Wyoming, as follows:

“The college or department of the arts shall embrace courses of instruction in the practical and fine arts; especially in the application of science to the arts of mining and metallurgy, mechanics, engineering, architecture, agriculture and commerce, together with instruction in military tactics and in such branches in the department of letters as are necessary to a proper fitness of students for their chosen pursuits, and as soon as the income of the University will allow, in such order as the wants of the public shall seem to require, the said courses in the sciences and their practical applications shall be expanded into full and distinct schools or departments.”

The Act of the Legislature of Wyoming, approved January 10th, 1891, placed the federal appropriations to aid Agricultural and Mechanical Colleges in the various states. known as the Morrill Act of Congress, approved August 30th, 1890, under the control of the Board of Trustees of the University of Wyoming for the support of the Agricultural College of the said institution; and also connected the Wyoming Agricultural Experiment Station with the University, also supported by the federal appropriation known as the Hatch Act of Congress, approved March 2nd, 1887. For five years these federal appropriations have been expended under the supervision of the Board of Trustees of the University of Wyoming in maintaining the Agricultural and Mechanical College of the institution, and in carrying forward, in connection therewith, scientific research in agriculture and animal industry, according to the requirements of the said respective Acts of Congress. This report therefore deals with these departments of the University of Wyoming, in compliance with the requirements of the said Federal Statutes.

The names of the Faculty, and the positions the Professors occupy in giving instruction in the Agricultural College, may be found on the introductory page of this report. Some of the Professors occupy similar chairs in the College of Liberal Arts. It has been found that by consolidation of the Faculties and classes economy of management can be secured, and the State can be saved considerable money in maintaining the educational facilities demanded by the desires of our patrons.

In the Appendix of this Report may be found the course of study in the Agricultural College, and also the

course of study in Mechanical Engineering, to which reference is hereby made. These courses of study cover a period of four years, and fully meet the requirements of the law in providing education for the industrial classes. Comparison with the Agricultural Colleges in other states shows that our courses of study in these departments are as thorough and complete as those of any Agricultural College in the United States. It is a fact that in this State of a small population, better facilities for education along practical and industrial lines can be offered the public in the departments connected with the University, than the State would be able to maintain by separate institutions. For the present at least, it would seem wise, from an educational standpoint, to continue these departments in connection with the University of Wyoming.

Wyoming is not yet an agricultural state, but it possesses great resources for agriculture, under a system of irrigation which will some day reclaim fully ten million acres of our fertile valley lands. Until this time arrives, purely agricultural students, in Wyoming, will necessarily be few. The industrial education now demanded in the State is along the lines of Mechanical, Mining and Electrical Engineering. At the present time our College of Mechanic Arts, fairly well equipped and in a separate building, is patronized by our students quite as liberally as any other department of the University. We have an increased number of bright students in these departments, who are making commendable progress. Especially does the College of Mechanic Arts become important because of its close relation to our School of Mining Engineering and Metallurgy, giving facilities for the students in our School of Mines to

master the fundamental principles of the Mechanic Arts.

The Treasurer's report for the United States fiscal year, ending June 30th, 1895, may be found in the Appendix, reference to which is hereby made. The report of the Treasurer to the Secretary of Agriculture and to the Secretary of the Interior shows that the funds have been properly expended according to the Act of Congress approved August 30th, 1890, in aid of the Agricultural and Mechanical Colleges.

CONDITION AND PROGRESS.

The laboratories and facilities for instruction in these departments have been considerably improved during the year. All apparatus, machinery and tools are in good condition, and are well cared for by the Professors in their respective departments, aided by efficient janitors.

No additional buildings have been erected during the year. The present buildings and their equipment enable us to fairly meet the public demands upon us for industrial education.

Commendable progress has been made in the work of instruction, especially in the College of Mechanic Arts, and in the departments intimately connected with this School. The average attendance in all the departments of the University has considerably increased during the year; and improvement in the scholarship and interest of our students is also apparent, so that we can report encouraging progress.

THE FACULTY.

No changes have been made in the Faculty during the present year, except that Captain Chas. A. Varnum of the Seventh Cavalry was detailed by the Secretary of War to

relieve 1st Lieutenant E. C. Bullock of the Seventh Cavalry, as Professor of Military Science and Tactics, on September 16th, 1895. While we regretted losing the efficient services of Lieutenant Bullock, yet the time of his detail having expired made a change necessary. Captain Varnum has efficiently entered upon the discharge of his duties as Professor of Military Science and Tactics, and Assistant Professor of Mathematics.

I take pleasure in making a part of this report statements prepared by the various Professors, relative to the quality and condition of the work of their respective departments, arranged according to the seniority of their appointment.

PHYSICS.

J. D. CONLEY.

The work in Physics has been more satisfactory during the past year than for any other period in the history of the institution, due principally to the new apparatus, also to the assistance given it by the Mechanical Department in charge of Prof. L. C. Colburn, under whose supervision a fine work table has been made for the Laboratory, and several other pieces of furniture.

There are also several pieces of apparatus in process of construction. All this goes to awaken a deep interest, not only in the Department of Physics, but also in the Mechanical Department. It shows to the young men that their work is appreciated, by the practical use that is made of it. Among the apparatus we have in the Laboratory are the following, viz:

Queen's Rotatory Air Pump and a good set of accessories with it, Attwood's Machine, Dynamo, Plunge-Battery, Voltmeter, Amperemeter, Spectroscope, Siren, Wheatstone's Bridge, Galvanometer, Geissler Tubes, and an excellent Stereopticon.

Besides the above named, all of the fine apparatus of the Meteorological Department, which is connected with the Department of Physics.

During the present year a fine Cathetometer was imported for the Laboratory by James G. Biddle of Philadelphia. A Pelton Water-wheel has also been added: it is a first-class motor and is of great service in the Laboratory.

Mr. Wm. Westlake, piano- and organ-maker, of Denver, is making an interesting piece of apparatus for us, to illustrate sound and music scientifically. It will consist of an air-chest like that of an organ, worked by two pedals; there will be an opening for a siren attachment, also openings for eight organ-pipes, with keys or stops. The organ-pipes are being made by our Mechanical Department.

The Laboratory is sufficiently large for our present classes. It is well lighted and ventilated, and well supplied with water, gas and electricity.

The course in Physics consists of five terms' work—two terms during the Second Preparatory Year and three terms of the Sophomore Year.

The Second Preparatory class uses Carhart & Chute's Elements of Physics for a text-book, and pursues during the fall term the general properties of matter, Gravitation, Falling Bodies, Energy, the Simple Machines, Hydrostatics, Specific Gravity, Atmospheric Pressure, etc.

During the second term Heat, Light, Electricity and

Magnetism are pursued. During both terms the text-book work is illustrated by interesting experiments and supplemented by lectures.

The class in Advanced Physics for recitation work have used Ganot's Manual as a text-book and recited three times each week throughout the year, besides working in the Laboratory two hours each week during the year.

The Physical Library consists of forty-five volumes, to which each student has access.

BIOLOGY.

AVEN NELSON.

The Department of Biology is making progress in the more important lines of the field it is trying to fill. The work in both Botany and Zoology is being placed more and more on a laboratory basis. The instruction in the lecture room follows the work in the laboratory, co-ordinating and enforcing the facts which the student has gained through his own investigation. His powers of observation and discrimination are greatly strengthened. Under this method students become more self-reliant and independent. Of course this method is efficient only in proportion to the efficiency of the instructor and the facilities of the laboratory. The conveniences of the latter are constantly being increased, and recent purchases make the apparatus more ample.

The courses remain the same as outlined in the curriculum and are ample in their scope for present demands, but,

as heretofore, every effort will be put forth to secure thoroughness and accuracy of results.

POLITICAL SCIENCES.

HENRY MERZ.

The Course of Study in this Department consists in a study of the growth of Civil Government in the United States, as expressed in the Constitution. Much attention is given to historical facts connected with the development of our system of government, beginning with the early New England Town Meeting. Later in the course full attention is given to the study of Constitutional Law, and International Law, devoting a term to each subject.

During the Senior year, two terms are devoted to the study of Economic Sciences, and their application to Society in its relation to industrial and governmental matters. The true functions of the State are discussed, and the new and growing science of Sociology is considered in all its aspects.

AGRICULTURE AND HORTICULTURE.

B. C. BUFFUM.

The course has not been changed since my last report. During the winter and spring terms I taught the Freshman class in Agriculture, by lectures. The first term the History of Agriculture, Classification of Soils, Drainage, Fer-

tilizers, Rotation of Crops and the Improvement of Cereals by selection, crossing and care, were briefly given.

In the spring term the lectures took up the more important Farm Crops, their history and cultivation, Farm Buildings, the Employment and Management of Labor, and Farm Accounts. In connection with this course the students work two or more hours each day in the greenhouse or upon the farm and grounds, for which they receive ten cents an hour. I also taught the Physical Geography class during the winter term.

Any one not able to take the regular four years course is invited to investigate our shorter courses in Agriculture. To those who wish it, we also offer a course in the science and practice of irrigation.

MATHEMATICS.

L. C. COLBURN, PROFESSOR.

C. A. VARNUM, ASSISTANT.

The Department of Mathematics furnishes instruction in pure and applied mathematics; while the schedule is the same as for last year the work has been increased. With the advancement of students in the technical courses new classes have to be provided for; when all courses are complete in classes, six mathematical classes have to be provided for in the fall term, eight classes in the winter term and nine in the spring term.

The rooms now used by the Mathematical Department are already in a crowded condition for some classes; if the

classes increase in enrollment during the next two years as for the last two, more room must be provided for seating and more black-board space for recitation.

A new Wye level has been added to the equipment of instruments for surveying and leveling.

Lieutenant Bullock's detail having expired, Captain C. A. Varnum has been appointed to fill the vacancy; he has been elected by the Board to fill the chair of Assistant in Mathematics.

MECHANICAL ENGINEERING.

L. C. COLBURN.

In submitting this report of the Department of Mechanical Engineering it is with much pleasure that I can state that the work of the department has been steadily growing during the past year.

There are now enrolled students in the Preparatory, Freshman, Sophomore and Junior years.

Fourteen students have taken wood-work during the fall term. The work during this term has been upon useful pieces of apparatus and furniture for the various departments; this has been done at small expense to these departments, thus leaving more of the appropriations of the departments for other things much needed by them.

The interest in the shop work has been greatly increased by this plan, as the students can see pieces of their own handiwork being put to useful purposes. Much other work of like nature could be done if the department could hold a larger stock of materials to work with.

The equipment of the shop has been increased by the purchase of a small lathe for iron-working. This will afford means of doing some of the repairs that are needed from time to time, while giving students practice upon applied work.

The attendance in this department could be greatly increased if the shops could be fully equipped with iron-working tools and machinery.

The schedule of studies remains the same as for previous years. This provides for five classes during the fall term, the same number in the winter term and six in the spring term.

This number of classes in connection with the mathematical work causes the combination of some classes during the same recitation period. This can not be done with advantage to the work.

The equipment of the drafting-room has been increased by the purchase of a fine protractor and section lines; several sizes of blue-printing frames are being made in the shop for the drafting room.

No experimental apparatus has yet been provided for the Engineering Laboratory; this will soon be needed.

The Mining Engineering Department and the Chemical Department are now engaged in investigations upon the mineral oils of the State. Much additional work, of great value, could be done by the Mechanical Department if an oil-testing machine could be purchased for accurately and completely testing the lubricating value of each oil and its distillates.

CHEMISTRY.**E. E. SLOSSON.**

The following courses of study in the Chemical Department of the University of Wyoming are offered to students in the College of Agriculture and Mechanics:

I.—Elementary Chemistry; two terms, fall and winter: three hours lectures and recitations and four hours laboratory work a week. The aim of this course is to give students a knowledge of the laws of chemical change, a practical familiarity with the principal elements and compounds and skill in the manipulations of apparatus.

II.—Qualitative Analysis: laboratory work ten hours a week, any term. Open to students who have taken Course I.

III.—Quantitative Analysis: laboratory work ten hours a week, any term. Open to students who have taken Courses I and II.

IV.—Organic Chemistry; spring term: lectures and recitations three hours and laboratory work four hours a week. A theoretical and practical study of the carbon compounds with special reference to the composition and relative value of foods. Open to students who have taken Course I.

V.—Agricultural Chemistry; lectures and laboratory work on the chemistry of plant growth and the application of chemical principles to practical agriculture, with special reference to the problems of the arid region; one term.

GEOLOGY.**W. C. KNIGHT.**

The regular work in Geology required from all students is a course requiring five hours per week for three consecutive terms, and a thesis upon some subject to be selected by the student under the direction of the instructor during the second term. This course will deal with general Geology and is intended to give the student a thorough and comprehensive idea of the great study.

Besides the regular course, studies in Advanced Geology are offered to those who wish to make a specialty of this subject or of any of its branches. It is absolutely necessary for a student who wishes to become proficient in this line of study, to go into the field and study from nature. The opportunities for students to study Geology at the University of Wyoming are in many respects superior to those of most institutions of learning. The University is located upon Triassic rocks; to the east rise the Laramie Mountains flanked by Paleozoic rocks; to the west are series of Jurassic and Cretaceous rocks, beyond which are the Medicine Bow Mountains, and only twenty miles away there is an extensive development of Tertiary rocks. The mountains on either side have an archean core which is well mineralized. The sedimentary rocks are rich in invertebrate and vertebrate fossil life, and also have valuable deposits of clay, gypsum, soda and coal. The nearness of the mines of gold, silver, copper, lead, iron and coal, and the quarries of limestone, sandstone, marble and granite, makes the location one of great value to the student of Geology.

There are in course of construction two geological maps, one of the State and one of the immediate vicinity of the University, for use of students. The latter map will be drawn on the scale of two inches to the mile and will include the Geology of the country for a radius of twenty-five miles from the University.

COURSE IN GEOLOGY.

I.—General Geology. Fall, winter and spring terms; five hours per week; forty hours field work and a thesis.

II.—Mineralogy. Five hours per week for twelve weeks.

III.—Economic Geology. Five hours per week for twelve weeks; twenty-four hours field work.

IV.—Paleontological Geology. Five hours per week for twelve weeks.

V.—Dynamic and Structural Geology. Five hours per week for twelve weeks.

VI.—Field Work and Thesis. Sixty hours in field work.

Text and reference books used: Dana, Geikie, Kemp, LeConte, Williams, Tarr and Nicholson.

ENGLISH.

CORA M. MCDONALD.

Since last report the Department of English has been enlarged, and its scope greatly improved. During the past year ninety-three students have received instruction in this

department. I herewith submit, in outline, the new course with such explanations as I deem necessary.

English I.—Sub-Preparatory Year.—All courses. Fall term; five hours a week. Reed & Kellogg's Grammar; Irving's Sketch Book. Winter term; five hours a week. Reed & Kellogg's Grammar; The Sir Roger de Coverley Papers in The Spectator. Spring term; five hours a week. Lockwood's Lessons in English; Miles Standish.

In reading the literary productions mentioned above, the principles of accidence and syntax and the simpler rhetorical principles are emphasized. The third term, the class begin a historical study of language, composition, rhetoric and literature. During the year nine short essays are written, three reproductions, three narrations, and three descriptions.

English II.—First Preparatory Year.—All courses. Fall term; three hours a week. Lockwood's Lessons in English; English Classics. Winter term; three hours a week. Lockwood's Lessons in English; English Classics. Spring term; three hours a week. English Classics.

Work in the historical study of language, in composition, rhetoric and literature is continued throughout the year. The following are read: Julius Cæsar, Twelfth Night, Ivanhoe, The Abbot, Webster's First Bunker Hill Oration, Second Essay on the Earl of Chatham. Six essays based on the productions are written.

English III.—Second Preparatory Year.—All courses. Fall term; one hour a week. Midsummer Night's Dream; DeFoe's History of the Plague in London; Macaulay's Essay on Milton. Winter term; one hour a week. Irving's

Tales of a Traveler; Scott's Woodstock. Spring term; one hour a week. Longfellow's Evangeline; George Eliot's Silas Marner. Essays are written upon these books and upon the authors represented.

The purpose of the work in preparatory English, Courses I, II, and III, is to teach the student to recognize good English, to help him in his efforts to use it, and to cultivate in him a taste for the best literature.

English IV.—Freshman Year.—Classical, Literary and Scientific courses. Fall term; four hours a week. Brooke's History of English Literature; Shakespeare. Winter term; four hours a week. Four representative writers. Spring term; four hours a week. Six representative writers.

Brooke's Literature is studied the first term that the student may get a general idea of the whole field of English literature. King Lear and As You Like It are critically read. The second term is devoted to the writings of Bunyan, Milton, Pope and Johnson. Third term; Scott, Dickens, Tennyson, Hawthorne, Emerson. The purpose is to study a few writings critically rather than to study many superficially. Due attention is given to authors from Shakespeare to Emerson who may be worthy of study, but most time is devoted to those who are the representatives of their respective periods. From time to time the class prepare essays on subjects connected with the work.

English V.—Junior Year.—Classical, Literary and Scientific Courses. Fall term; three hours a week. Gennung's Rhetoric and Rhetorical Analysis. Lectures, The English Drama, and Shakespeare. Winter term; three

hours a week. Genung's Rhetoric and Rhetorical Analysis. Lectures, The English Lyric, and English Prose. Spring term; three hours a week. Genung's Rhetoric and Rhetorical Analysis. Lectures, The Novel, and American Literature.

The aim of this course in Rhetoric is to ground the student in the principles of English composition, to cultivate his literary sense by an analytical study of pure selections from the best writers, and to give him sufficient practice in the writing of essays to enable him to compose with ease and rapidity. The work consists of:

(a) Extensive drill in the choice of words, in the structure of sentences, and in the formation of paragraphs; also a careful study of the forms of discourse,—description, narration, exposition, argumentation and persuasion;

(b) An analytical study of a number of literary models in connection with the theoretical work of the rhetoric proper;

(c) The writing of six essays, two narrations, two descriptions, one exposition and one argumentation.

English VI.—Senior Year. Fall term. Elective, Whitney's Life and Growth of Language. Winter term. Elective, Anglo-Saxon and Early English.

It is the aim of the fall term to give some attention to the determination of cognate words in Latin, Greek, French and German, that the essential unity of the Aryan family may be impressed on the mind of the student. Lectures on subjects bearing directly on the work are given from time to time, original research is required, and topics are assigned for essays to be read before the class. The work of

the fall term prepares the student for the work of the winter term; Anglo-Saxon and Early English are historically studied and selections from Chaucer and Spenser critically read.

ELOCUTION AND ORATORY.

The work in elocution and oratory is of a practical character. The aim is to give students such training as shall best prepare them for the duties of citizenship. As far as possible all students are given personal attention, that their respective needs may be learned and that such instruction may be given them as shall be productive of the best results. The work consists in exercises in breathing, pronunciation, stress, emphasis, position and gesture, and drill in reading and speaking, that a sensible and effective style of oral expression may be acquired.

MILITARY SCIENCE AND TACTICS.

CAPT. CHAS. A. VARNUM, 7TH U. S. CAVALRY.

I have the honor to submit the following report of the Department of Military Science of this institution during the year ending Dec. 31, 1895.

The total number of students under instruction during the year is as follows:

Winter term	-	-	-	39
Spring term	-	-	-	32
Fall term	-	-	-	36
Average				35 $\frac{2}{3}$

During the period of study of the University the Cadets have reported for instruction four (4) times per week. All male students are required to attend, unless specially excused for good reasons by the President of the University.

The equipment consists of Springfield rifles, Cal. 45; cavalry sabres, and two (2) 3-inch Ordnance guns and limbers.

Instruction has been both practical and theoretical and as follows:

INFANTRY.

School of the Soldier and Company, and theoretical instruction only in Battalion and Minor Tactics and field fortifications. Guard mounting and duty as sentinels, both practical and theoretical.

Small arms firing regulations. Position, aiming and sighting drills, gallery and range practice, the latter being at 100, 200 and 300 yards.

ARTILLERY.

Standing gun drill.

CAVALRY.

Manual of the Saber, dismounted, and lectures on Equipment and Use of Cavalry.

MILITARY SIGNALING.

With flags, for all after 1st Preparatory Course, and heliograph for college students.

First Lieutenant E. C. Bullock, 7th Cavalry, U. S. A., was relieved from duty in this department September 16th, 1895, and Capt. Chas. A. Varnum, 7th Cavalry, reported for duty as his successor on that date.

LIBRARY.

G. R. HEBARD, ASSISTANT LIBRARIAN.

The Library, which is also the general reading room of the University, is situated on the second floor, in the north wing of the main building. This is a large, well lighted and ventilated apartment. The college students use this room, during vacant hours, from 8:30 a. m. to 12 m., and from 1 to 3:15 p. m.

The students at all times during the day, for five days in the week, have free access to all the books and periodicals. Three volumes may be taken by any one individual and kept from the shelves for a period of two weeks. Books reserved at the instance of professors as collateral reading for their courses, are shelved in their respective rooms, and can be taken out only on application to such professors, who are responsible for them during the period of their reservation.

The Library contains 3,926 bound volumes, and in addition several thousand unbound bulletins and reports on agricultural and scientific subjects.

There have been added to the University Library during the year 1895, 774 bound volumes and 350 pamphlets, including Experiment Station Bulletins and publications from the Department of Agriculture at Washington, D. C.

During the year past the Library has received from Rev. Jacob Norris, one of the Trustees of the University, a valuable donation of fifty books on the subject of mathematics.

The Board of Trustees of the University, at its annual meeting in June, 1895, made an appropriation of nine hun-

dred and twenty-five dollars for reference books for the Library. Four hundred and twenty-five dollars of this amount were for scientific and technical books, four hundred dollars were appropriated for standard works for use in the departments of English and History, and one hundred dollars for scientific and general periodicals. The scientific books as purchased, after being catalogued, are placed in the reference libraries in the respective laboratories in the University, the books for more general use being placed in the Library proper. A pleasing increase of interest in the Library has been shown by the students during the past year; the books are consulted with greater care, and the knowledge obtained has been particularly noticed in the departments of English and History.

Forty-two of our State papers are donated by the publishers to the Library, and in addition to these the following list of agricultural papers are also sent to the University:

Arkansas—	Illinois—
Farmer.	Prairie Farmer.
California—	Orange Judd Farmer.
Press and Horticulturist.	Farmers' Review.
West American Science.	The Farmer's Magazine.
Colorado—	The Elgin Dairy Report.
Farmer.	Irrigation Age.
The Mining Review.	Iowa—
The Field and Farm.	Iowa Homestead.
Georgia—	Kansas—
The Southern Cultivator.	Farmer.
Indiana—	Kentucky—
Clover Leaf.	The Industrial American.

Louisiana—	New Mexico.
Planter.	Southwestern Farm
Maryland—	and Orchard
Farmer.	New York—
Baltimore Weekly Sun.	American Agriculturist.
Southern State.	Rural New Yorker.
Massachusetts—	Sugar Trade Journal.
Farm and Home.	Ohio—
Ploughman.	American Grange Bulletin.
Our Grange Home.	Pennsylvania—
American Cultivator.	Germantown Telegraph.
New England Farmer.	Virginia—
Michigan—	Southern Planter.
Grange Visitor.	The Progressive South.
Missouri—	Washington—
National Dairyman.	Northwest Mining Review.
Nebraska—	Wisconsin—
Western Resources.	Hoard's Dairyman.
New Hampshire —	Ontario—
Mirror and Farmer.	Farmer's Advocate.

The scientific and general periodicals taken by the Library and kept on the tables of the reading room are:

American Machinist,	Agricultural Science,
Arena,	Annals of American Acad-
American Chemical Journal,	emy of Political and Social
American Naturalist,	Science,
American Gardening,	Bulletins of the Torrey
American Journal of Science,	Botanical Club,
American Geologist,	Botanical Gazette,
American Journal of Civics,	Century,

Cosmopolitan,	Meteorological Journal,
Colliery Mining Magazine,	Microscope,
Die Garten-laube,	Microscopical Journal,
Education,	Mining and Scientific Press,
Educational Review,	Monist,
Electrical World,	North American Review,
Engineering Magazine,	Nineteenth Century,
Erythea,	Outlook,
Fliegende Blätter,	Political Science Quarterly,
Forum,	Political Science Monthly,
Independent,	Psychological Review,
Harper's Weekly,	Philosophical Review,
Harper's Monthly,	Review of Reviews,
Journal Society of Chemical Science,	
Industry,	Scientific American and
Journal of the Chemical Supplement,	
Society,	Scribner,
Literary Digest,	Young Men's Era.

The University uses the Dewey Decimal Card Catalogue system, and in addition to the regular cards we have those coming from the Department of Agriculture at Washington, containing a complete list of publications sent from that department and its several branches in connection with the Experiment Station work.

APPENDIX.

- I. Courses of Study.
- II. Treasurer's Report.

COURSES OF STUDY.

The College of Agriculture, State of Wyoming, was reorganized at the opening of the present University year, with additional buildings, laboratories and instructors, and now offers to the youth of Wyoming the following courses of instruction in Agriculture, Mechanic Arts and Military Science:

I. A ONE YEAR'S COURSE.

For those whose time is limited, but who wish some practical instruction in farming and ranching. The studies are so arranged that students from the district schools can enter at the beginning of any term. The recitations and lectures are with the regular University classes, a certificate is given for work done, and the grades may be credited toward the longer courses. The fall term includes: Book-Keeping or Physiology, Drawing, English Grammar or Rhetoric, Arithmetic or Algebra, and Wood-Working. The winter term embraces: Book-Keeping or Physical Geography, History and Principles of Agriculture, Botany or Horticulture, Arithmetic or Algebra, and Metal-Working. The spring term is devoted to: Book-Keeping or Civil Government, the Agriculture of Soils and Tillage.

Botany or Horticulture, Zoology or Geometry, and Field and Laboratory Work.

II. A TWO YEARS' COURSE.

Including the above and selected studies from the second and third years of the complete course.

III. A FOUR YEARS' GRADUATING COURSE.

Devoted to a thorough training in Agriculture. (See course of study.)

IV. A GRADUATE COURSE.

For graduates who wish to devote their time to special research in the fields and laboratories of the Agricultural Experiment Station.

SPECIAL CHEMICAL STUDENTS.

The chemical laboratory is fitted up with a view to making it as useful as possible to the State at large, and good opportunities are offered for carrying on special investigations, or courses of study. Prospectors who wish to take a course in Determinative Mineralogy, pharmacists who desire to perfect themselves in Chemistry before taking examinations or going away to a school of pharmacy, and especially those contemplating the establishment of some industry developing the natural resources of Wyoming, will be given every available facility for their work. The study being individual and not in classes, hours can generally be arranged to suit the student. The only requirement is sufficient previous knowledge to undertake the line of work desired. Tuition is free; apparatus broken and chemicals used are charged at cost.

EXPENSES.

Tuition is free to all resident students of Wyoming; non-residents will be required to pay an annual fee of \$5.00. An incidental and library fee of \$2.50 a year must be paid by all students.

SCOPE OF THE COLLEGE.

The College of Agriculture is designed to give to young men, who may desire it, the advantages of a thorough, liberal and practical education, not only to prepare them for the successful prosecution of agriculture in all its branches, but to secure to the student the mental discipline and training necessary to qualify him for any other calling or profession, and fit him to discharge intelligently the duties of an American citizen. The period of study requisite for graduation will extend through four years.

Students completing the course will receive the degree of Bachelor of Agriculture, and such students pursuing one year of graduate studies in the University will receive the degree of Bachelor of Science.

REQUIREMENTS FOR ADMISSION.

Students will be admitted to the Agricultural course by passing a satisfactory examination in Arithmetic, English Grammar and Composition, Physiology, United States History, Physical Geography and Elementary Algebra.

COURSE OF INSTRUCTION.

The instruction in this college will be given at the University building, and the practical instruction will be given on the Agricultural College Farm and at the Experiment Station at Laramie.

Agricultural College Course.

FRESHMAN.

FALL TERM.	WINTER TERM.	SPRING TERM.
Algebra General History Physics Drawing English, 3 hours Shop Work, 2 hours	Algebra Agriculture Physics Botany I Rhetoricals	Algebra Agriculture Physics Botany I Rhetoricals

SOPHOMORE.

Algebra Advanced Physiology Anatomy Chemistry I Botany II Botanical Essays	Plane Geometry Agriculture Chemistry I Zoology I Agricultural Essays	Solid Geometry Agriculture Chemistry II Zoology II Essays
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JUNIOR.

Plane Trigonometry Psychology English Literature Irrigation Essays—Speech	Mechanics Logic Literary Criticism Meteorology Horticultural and Physical Essays	Spherical Trigonometry and Surveying Agricultural Chemistry Agricultural Engineering Entomology Agricultural and Entomologi- cal Essays Speech
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SENIOR.

Political Economy Horticulture Veterinary Geology Political Economy, Essays, Speech	International Law Horticulture Veterinary Geology Technical Essay, Speech	Thesis Landscape Gardening Organic Chemistry Mineralogy Oration
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Military drill the same as in other courses. Afternoons and two hours for laboratory and field work. To lead to degree of B. Agr. Graduate courses leading to degree of B. S. or M. Agr.

College of Mechanic Arts.

ADMISSION.

Students will be admitted to the Mechanical Course by passing a satisfactory examination in Arithmetic, English Grammar and Composition, Physiology, United States History, Physical Geography and Elementary Algebra.

SPECIAL INSTRUCTION IN THE MECHANICAL DEPARTMENT.

All desiring special instruction in Mechanical Drafting, Higher Theoretical Mechanics and Engineering, should examine the new course of study in the Mechanical Department. Mechanical Drafting can be commenced in any term and be pursued as rapidly as the skill of the student will permit, as all work depends solely upon the student's ability.

Any branch of the higher mechanics can be pursued if the elementary principles are well understood by the student.

Mechanical Course.

PREPARATORY.

FALL TERM.	WINTER TERM.	SPRING TERM.
Algebra, 5 Elementary Physics English, 3 Mechanical Drawing	Algebra, 5 Elementary Physics English, 3 Mechanical Drawing, 5	Algebra, 5 English, 3 Free-hand Drawing

Rhetorical work the same as other courses.
Shop work two hours each afternoon.

FRESHMAN.

Algebra, 5 French or German, 5 Mechanical Drawing, 5	Plane Geometry, 5 French or German, 5 Descriptive Geometry, 5	Solid Geometry, 5 French or German, 5 Kinematic Drawing, 5
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Rhetorical work the same as other courses.
Shop work two hours each afternoon.

SOPHOMORE.

Plane Trigonometry, 5 French or German, 5 Chemistry I, 5	Elementary Mechanics, 5 Chemistry I, 5 French or German, 5	Spherical Trigonometry and Surveying, 5 Mechanical Drawing French or German, 5
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Rhetorical work the same as other courses.
Shop work two hours each afternoon.

JUNIOR.

Advanced Physics, 5 Analytical Geometry Chemistry of Metals, 5	Advanced Physics, 5 Differential Calculus, 5 Elements of Mechanism, 5	Advanced Physics, 5 Integral Calculus, 5 Machine Design, 5
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Technical reading from engineering magazines and papers once per week.

SENIOR.

English Literature, 5 Analytical Mechanics, 5 Machine Drafting, 5	Mechanics of Materials, 5 Steam Engine, 5 Astronomy, 5	Thermo-dynamics, 5 Hydraulics, 5 Thesis Work
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Laboratory work in engineering in afternoon.

Shop work each term, during entire course, in wood shop, blacksmith shop, foundry and machine shop. Military drill each term during first two years. This course leads to B. E. A two years' graduate course leads to M. E.

Treasurer's Report.

UNIVERSITY OF WYOMING, }
 AGRICULTURAL COLLEGE, }
 LARAMIE, WYO., June 30, 1895. }

Report of Treasurer of said institution, to the Secretary of Agriculture and the Secretary of the Interior, of amount received under Act of Congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts, and of the disbursement thereof, to and including June 30, 1895.

BALANCE on hand July 1, 1894.....		\$ 1,774.73
Date of receipt of installment for 1894-95, August 29, 1894		20,000.00
TOTAL available for year ending June 30, 1895.....		21,774.73
DISBURSEMENT thereof for and during the year ending June 30, 1895:		
Agriculture	\$ 1,702.29	
Mechanic Arts	2,212.70	
English Language	1,866.42	
Mathematical Science	856.83	
Natural and Physical Sciences	6,184.03	
Economic Science	4,167.00	
TOTAL expended during the year		16,989.27
BALANCE remaining unexpended July 1, 1895.....		\$ 4,785.46

I hereby certify that the above account is correct and true, and truly represents the detail of expenditures for the period and by the institution named, and that said expenditures were applied only to instruction in Agriculture, Mechanic Arts, the English language, and the various branches of Mathematical, Physical, Natural and Economic Science, with special reference to their applications in the industries of life, and to the facilities for such instruction.

OTTO GRAMM,
Treasurer.

UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,

LARAMIE, WYOMING.

FIFTH ANNUAL REPORT.

1895.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

BOARD OF TRUSTEES.

HON. STEPHEN W. DOWNEY, PRESIDENT, Laramie	1897
GRACE RAYMOND HEBARD, SECRETARY, Cheyenne	1897
OTTO GRAMM, Laramie	1897
REV. JACOB NORRIS, Laramie	1899
PROF. JAMES O. CHURCHILL, Cheyenne	1899
HON. JAMES A. McAVOY, Lander	1899
HON. TIMOTHY F. BURKE, Cheyenne	1901
HON. JOHN C. DAVIS, TREASURER, Rawlins	1901
HON. CARROLL H. PARMELEE, Buffalo	1901
STATE SUPT. ESTELLE REEL,	<i>Ex-Officio</i>
PRESIDENT ALBINUS A. JOHNSON	<i>Ex-Officio</i>

AGRICULTURAL COMMITTEE OF THE BOARD OF TRUSTEES.

OTTO GRAMM, CHAIRMAN	Laramie
S. W. DOWNEY	Laramie
JACOB NORRIS	Laramie

PRESIDENT OF THE UNIVERSITY OF WYOMING.

A. A. JOHNSON, A. M., D. D.

STATION COUNCIL.

A. A. JOHNSON, A. M., D. D.	DIRECTOR
G. R. HEBARD, A. M., Ph. D.	SECRETARY
B. C. BUFFUM, M. S.	AGRICULTURIST AND HORTICULTURIST
J. D. CONLEY, A. M., Ph. D.	PHYSICIST AND METEOROLOGIST
AVEN NELSON, M. S., A. M.	BOFANIST
E. E. SLOSSON, M. S.	CHEMIST
W. C. KNIGHT, A. M.	GEOLOGIST

SUPERINTENDENTS.

JACOB S. MEYER	LANDER EXPERIMENT FARM
JOHN D. PARKER	SARATOGA EXPERIMENT FARM
JOHN F. LEWIS	SHERIDAN EXPERIMENT FARM
A. E. HOYT	SUNDANCE EXPERIMENT FARM
MARTIN R. JOHNSTON	WHEATLAND EXPERIMENT FARM
B. C. BUFFUM	WYOMING UNIVERSITY EXPERIMENT FARM
THE HORTICULTURIST IN CHARGE,	WYOMING UNIVERSITY EXPERIMENT GROUNDS

FIFTH ANNUAL REPORT
—OF THE—
WYOMING AGRICULTURAL EXPERIMENT STATION
FOR THE YEAR 1895.

As Director I have the honor to include in this report a statement of the completed work of the Wyoming Agricultural Experiment Station for the year 1895, together with a financial statement of the Treasurer for the fiscal year ending June 30th, 1895.

The completed work of the Station for the year is contained in six Bulletins, and a full text of each appears in the succeeding pages of this report, to which reference is hereby made, with the suggestion that these Bulletins will be found to be of great interest, on practical subjects, and carefully prepared by the scientific members of the Station staff. These Bulletins and their subject matter are as follows:

Bulletin No. 21, "Grain Smuts and Potato Scab."

Bulletin No. 22, which is of the nature of a "Crop Report for 1894," dealing especially with reports on the grow-

ing of onions and various other root crops, grasses and forage plants, cereals and small fruits, on the farm at Laramie.

Bulletin No. 23, "Meteorological Report for 1894, and Notes on Climate."

Bulletin No. 24, "Water Analyses," dealing especially with the problem of alkali salts in irrigation water, together with analyses of the various waters found in the springs and wells of the State.

Bulletin No. 25, "Results of Three Years' Experiments on the Cost and Profit of Growing Wheat."

Bulletin No. 26, "Garden Peas."

I include in the completed work of the Station for this year the reports of our Farm Superintendents, which will be found of interest and value, as setting forth the success of agriculture in their respective localities.

Under the head of Press Bulletins will be found matters of general interest, to which reference is hereby made.

CO-OPERATIVE SEED TEST.

A quantity of garden seeds, grasses and forage plants were furnished the Station by the Department of Agriculture, for a co-operative seed test, under the direction of the Director of Experiment Stations, to determine the best varieties. A quantity of seeds grown on our Farms was also used for this purpose, and about one hundred and thirty farmers and ranchmen of the State were furnished seeds, on condition that they would grow and cultivate the same, and carefully report results at the end of the season. The test has not been satisfactory, as the reports are so meager and general in their nature as to be of no scientific value. I would not recommend the continuation of this experiment, nor the distribution of seed, except to introduce improved

and well-tried varieties of cereals, root crops and garden, vegetables suited to this climate.

PLAN OF STATION WORK FOR 1895.

The outline of the general experiments in agriculture as carried forward on our Experiment Farms, and the work carried forward in the scientific departments of the University for 1895 is as follows:

DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

1. Cost and profit of growing Wheat upon a test acre plat. This experiment having been carried on for three years, ends with 1895, and the average for the three years gives approximately the cost and profit of raising wheat in Wyoming.
2. Potato Experiment. A test of varieties.
3. Smutty Grain. Treat a part for smut, and leave a part untreated, to determine the effect and value of the treatment.
4. Experiment with Forage Plants.
5. Experiments in Rotation of Crops, keeping careful records of same in Soil Record Book.
6. Experiments with Orchard and Small Fruits.
7. Test for growing Celery.

CHEMICAL DEPARTMENT.

1. Analyses of irrigation and mineral waters. Effect of irrigation on the alkali in the soil.

2. Composition and food value of prepared grain foods.
3. Study of methods of analysis and calorimetry with bomb calorimeter.
4. Tests of food products for the detection of adulterations.
5. Analyses and tests of food value of native and cultivated forage plants.
6. Direction of fertilizer experiments on some of the Farms.

BOTANICAL DEPARTMENT.

1. Work on the collection and determination of the flora of the State.
2. In connection with No. 1, the preparation of Herbarium specimens, with duplicates for exchange.
3. The study of the weeds of the State as to their prevalence, obnoxious qualities, methods of propagation, and means for their eradication.
4. The study of the injurious fungi of the State, particularly the rusts and smuts of grains, and the blights, mildews, scabs and rots of fruits and vegetables.

DEPARTMENT OF IRRIGATION ENGINEERING.

1. Continuation of the experiments to determine the duty of water on the Wheatland and Laramie Experiment Farms.
2. Study of seepage irrigation *versus* flooding, on the Laramie and Wheatland Farms.
3. Continuation of experiments on sub-irrigation on the University Campus, and experiments with clay pipe tiling on the Laramie Farm.

DEPARTMENT OF METEOROLOGY AND SOIL PHYSICS.

METEOROLOGY.

1. Continuation of the work of making observations and co-operating with the State and United States Weather Service.
2. Observations on the precipitation from as many places in the State as possible.
3. Observations upon the direction and force of the air currents at Laramie.

SOIL PHYSICS.

1. Investigation of the physics of the soil.
2. Petrographic determination of the coarse admixed parts of the sand.
3. The behavior of soils toward water:
 - a. The power of retaining moisture in the soil;
 - b. The evaporating power of the soil;
 - c. The filtrating power of the soil;
 - d. The capillary attraction of the soil.
4. Cohesion and adhesion of the soil.

DEPARTMENT OF GEOLOGY.

1. Wind erosion as a factor in soil production.
2. A study of the various formations entering into soil composition, to ascertain whether they are beneficial or detrimental.

3. To ascertain, if possible, some new methods of securing water for irrigation purposes where nature has not provided streams; and in other places, where water is not sufficient to warrant farming on an extensive scale.

STOCK FEEDING EXPERIMENTS.

At the annual meeting of our Board of Trustees in June, 1895, a Farm for Experiments in Animal Industry was established at Lander, in connection with the Agricultural Experiment Farm, and a sufficient appropriation was made to thoroughly equip the farm for experiments in stock feeding, stock breeding and stock growing, with especial reference to the breeds and methods best suited to the peculiar conditions prevalent in the arid regions. In connection with the work of the Farm of Animal Industry it is proposed to study the animal diseases as found in Wyoming, and the remedies for the same. A stock-feeding experiment is now in progress, and a Bulletin will be issued in due time, in regard to the value of feeding cattle and sheep preparatory to marketing, rather than shipping them direct from the great plains over which they have been accustomed to roam. The stockmen of the State are showing considerable interest in the work of this new Farm of Animal Industry, and we trust that the results will be gratifying to all concerned.

GENERAL STATEMENT.

The Station is now better equipped with apparatus and facilities for scientific work; and its staff of workers is more experienced and better acquainted with the conditions affecting the agricultural interests of the State than hereto

fore. It is believed that this fact will make the experiments under way more comprehensive, and of greater value to the State.

The Station is becoming better known to our farmers, as indicated by the increase in the correspondence, and the applications for Bulletins. I have endeavored to secure the names of intelligent farmers and ranchmen in the State and add them to our mailing list, so that our Bulletins may reach those who are likely to be benefitted by them.

The report of the Treasurer is herewith made a part of this report, to which attention is invited, showing that the funds of the Station are expended in harmony with the enactment of Congress.

The reports of the Station Workers, together with the six Bulletins issued by the Station, are herewith submitted.

Respectfully,



Director.

Treasurer's Report.

WYOMING AGRICULTURAL EXPERIMENT STATION,

LARAMIE, WYOMING,

—IN ACCOUNT WITH—

THE UNITED STATES APPROPRIATION, 1894-5.

Dr.		
To Receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1895, as per Act of Congress approved March 2, 1887		\$15,000.00
Cr.		
By Salaries	\$ 5,284.22	
Labor	5,322.18	
Publications	801.56	
Postage and Stationery	239.47	
Freight and Express	249.85	
Heat, Light and Water	116.07	
Chemical Supplies	44.63	
Seeds, Plants and sundry supplies	463.75	
Fertilizers	9.50	
Feeding Stuffs	69.65	
Library	100.00	
Tools, Implements and Machinery	367.34	
Furniture and Fixtures	51.40	
Scientific Apparatus	405.64	
Traveling Expenses	924.99	
Contingent Expenses	150.19	
Building and Repair	399.46	
Balance		
	\$15,000.00	\$15,000.00

We, the undersigned, duly appointed auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1895; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the

United States are shown to have been \$15,000.00, and the corresponding disbursements \$15,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

[SIGNED] JOHN C. DAVIS,
[SEAL] JAS. A. McAVOY,
Auditors.

ATTEST:

GRACE RAYMOND HEBARD,
Custodian.

SUPPLEMENTARY STATEMENT.

DR.	
To Receipts from sale of Farm Products	\$427.73, \$427.73
CR.	
By Traveling Expenses.....	427.73 427.73
Balance.....	

REPORT OF PHYSICIST.

J. D. CONLEY.

During the summer of 1895 our Agriculturist visited the various Experiment Farms, and under his direction six soil samples were taken at each Farm, and copious notes made as to the location, history, etc., of each sample kept

for us—there being thirty samples in all. Hilgard's Elutriator has been purchased, and a 6-inch Pelton Water wheel as a motor, and other apparatus with which a physical analysis of the soils will be made and a Bulletin of the results issued.

REPORT OF THE METEOROLOGIST.

J. D. CONLEY.

The observations in the Meteorological Department have been carried out along the same lines as during the past five years.

At the University the following records have been kept, viz: Of Precipitation. The maximum and minimum temperature, taken at 7 a. m. and 7 p. m. Draper's Self-recording Thermometer, by which the temperature for every minute of the day is kept and recorded on a paper dial, is used.

The Velocity of the Wind, as shown by the Anemometer, also the Direction of the Wind, both of which are recorded by an automatic electric instrument made by Julien P. Friez, of Baltimore. Records of Evaporation, Dew-Point, and Relative Humidity are kept each day. The readings of the Barometer are taken at 7 a. m. and 7 p. m.

There is also a Self-registering Barometer that gives approximate readings for every minute of the day.

Daily records are kept of the precipitation, maximum and minimum temperature, and the percentage of sunshine by the Superintendents of Lander, Saratoga, Sheridan, Sundance and Wheatland. There are also nine volunteer observ-

ers, who report monthly the precipitation and temperature of their respective localities. From the data secured during the past five years we are preparing Notes on Climate to be issued with the Meteorology for 1895.

Mr. Fred Nelson resigned his position as Assistant Meteorologist last October to attend a Theological Seminary in Chicago. Mr. James Cowan was chosen as his successor and is the Assistant at the present time.

REPORT OF THE BOTANIST.

AVEN NELSON.

Work upon the collection and determination of the flora of the State has gone steadily forward. Most of the material from the collections of 1894 was worked up during the earlier months of 1895, and specimens of all species and varieties placed in the herbarium. The rest of the material was distributed into sets, which have in part been sent out in exchange for other plants.

Field work occupied the larger part of the summer vacation. No special effort was made to reach distant parts of the State, but every effort was made to work carefully the most promising adjacent territory. To this end four expeditions were planned and carried out. As only rare forms and such as had formerly been overlooked were collected, the number of species secured, of course, is not so large as in 1894.

The first expedition left Laramie June 27, going to the east and working Pole Creek, Table Mountain and adjacent territory, 103 species being secured. The second left Lar-

amie July 25, camp being established at Cummins City, from which point the surrounding mountains and valleys were searched for treasures, and resulted in 123 numbers. The third expedition left for Laramie Peak on August 3d and returned with 117 numbers. The fourth expedition made two camps, one in the Centennial valley and one at the LaPlata mines near the summit of the Medicine Bow (Snowy) range. From these two points adjacent territory was worked and yielded 192 species, many of them quite rare.

Besides the above species, there were collected at various times during the season 135 numbers, making a total for 1895 of 670 numbers. As these are all in duplicate, approximately in tens, the total number of specimens is near 6,700.

Of the 670 species it is believed that over half are new as compared with last season's collections, and a few, it is thought, may prove to be species new to science.

All the material is being worked up as rapidly as possible; about half of the work having now been accomplished.

The results of the past two seasons' work it is hoped may be such as to warrant the publication soon of a preliminary bulletin on the flora of Wyoming.

One bulletin has been issued during the year, viz: "The Smuts of Grain and Potato Scab." This briefly described the two most serious fungal diseases prevalent in the State, giving the methods of infection and the best means of preventing the same.

Notes upon, and specimens of other fungi have been collected, and as soon as the information at hand seems to warrant it, a bulletin on the subject will be offered.

A co-operative experiment with oats smut has been carried out at the instance and under the direction of the Vermont Station. For the supervision of this I am under obligation to Prof. Buffum.

The weed problem is becoming more serious and will demand more attention during the coming year. Both the Canada and the Russian thistle have secured a foothold in the State. Through the kindness and assistance of Prof. Buffum and the Superintendents of the Experiment Farms fairly complete lists of the weeds, and herbarium specimens of the more important ones, were secured from each of the Farms.

Two herbarium cases have just been added to receive the acquisitions expected soon to arrive in return for material sent out.

REPORT OF THE CHEMIST.

E. E. SLOSSON.

Most of the time available for station work during the past year has been devoted to water analyses. Complete analyses have been made of samples from the most important irrigation systems of the State, and a more detailed study has been made of the irrigation and waste water on the Laramie Farm in order to determine the effect of the composition of irrigation water and of different methods of irrigating on the amount of alkali in the soil. The results were published in Bulletin No. 24, together with a number of analyses of water from wells and mineral springs in all parts of the State. Some of the irrigation waters analyzed

contained so large an amount of alkali that they are liable to do more harm than good to the land unless immediate precautions are taken.

I am now engaged in the analysis of prepared cereal foods. The use of partly cooked preparations of oats, corn and wheat, put up in packages and sold under fancy names, has become very extensive, and the wide difference in their price and composition make it desirable that people should be informed as to their real value.

REPORT OF THE GEOLOGIST.

· WILBUR C. KNIGHT.

Work has been continued on three lines of investigation during the year, but sufficient data have not been secured to warrant their publication.

During the summer months I examined the following localities, with reference to soil formation, wind erosion, and artesian basins: the arid region lying north of the Rattlesnake Mts., the desert lands lying between Deer Creek in Natrona County and Beaver Creek in Fremont County, the country between Casper and the Powder River, the Sweetwater valley, North Platte River valley, Bate's Hole, Shirley Basin, and the valley of the Big Medicine Bow River.

Work will be continued during the coming season, and a bulletin upon one of the above topics may be looked for during 1896.

REPORT OF THE
AGRICULTURIST AND HORTICULTURIST.

B. C. BUFFUM.

The plans for the year have been quite fully carried out. As we become better established and are able to obtain more efficient help, a larger amount of original investigation is possible.

In addition to the regular work of the Station, much was taken up during the winter and spring terms, in giving instruction to the classes in the University and the Agricultural College.

The Station publications written by me during the year are: Bulletin No. 22, "Crop Report", Bulletin No. 25, "Cost and Profit of Growing Wheat", Bulletin No. 26, "Garden Peas", and Press Bulletin No. 3, on Sacaline.

During August and the first part of September I inspected all the Experiment Farms in the State, keeping full notes which have been put in permanent form and filed in my office.

Although the season was unusually short, cold and unfavorable for plant growth, the crops upon the Laramie Experiment Farm have been very successful, though they did not produce as heavy yields as last year. Two hundred and ninety-varieties of crops were grown. The special lines of crops have been: test of potatoes, test with peas, forage and other crops. Samples of the cereals raised have been placed on exhibition in my room, and make a creditable display.

We have been fortunate in securing most excellent help. One of our students, Mr. Charles Beach, was se-

cured to work upon the farm. Mr. H. S. Kendall went to the Lander Farm the first of July, and Mr. W. H. Fairfield was employed as my assistant. Mr. Fairfield is a trained observer and agriculturist, and his careful work will show in all reports and records for the year.

Careful measurements of the water used for irrigation were kept during the season. We now have on hand data from three years' measurements, and hope to make the necessary computations to report results before next season's work begins.

By the use of the greenhouse we were enabled to decorate the Campus during the summer with plants and flowers, which improvement was greatly appreciated by the public. The greenhouse is so small that few plants are being grown in it this winter, as the space has been reserved for an alkali experiment and other investigations. Less was appropriated for this department this year than ever before. No improvements have been made, and with the exception of a team and wagon no implements were purchased for the farm. However, we have carried on a large amount of investigation, and so far as the work of the department is concerned, it has never been in a more satisfactory condition.

I take this opportunity to thank my co-workers and all those who have been interested and assisted in any way.

LANDER EXPERIMENT FARM,

J. S. MEYER, SUPERINTENDENT.

I herewith present the Annual Report of the Lander Experiment Farm for the year 1895.

The season of 1895 may be considered as a poor growing season. Spring opened up late; we had continual wet weather and heavy frosts up to June 17th. Real summer weather did not begin till along in July, and then we did have good growing weather. The first killing frost was September 6th and 7th. There were several light frosts the latter part of August. Snow fell September 25th, and from that time till the end of the season more or less snow was lying on the ground.

Crops were put in during May, but owing to the weather a great deal of the seed rotted. Plant growth was slow, and while some crops did fairly well, none but small grains can be considered as successful when compared with former years.

Of those crops that may be considered as failures the timothy is probably first, as it made no growth from either top or roots. The season being so wet it rotted most of the seed of sorghum, broom-corn, field and sweet corn, pumpkins, pumpkins and squashes, and what did grow failed to mature.

Of the forage crops, alfalfa made an average crop; timothy, red clover, timothy and brome grass yielded very well.

Twelve acres of the upper bench land were cleared of brush, and broken, in order to plant alfalfa in the fall.

The wheat, oats and rye made successful crops.

The small fruits made a good crop, with the exception of a few late varieties of blackberries which gave but one picking before frost.

The red and white currants, gooseberries, raspberries

and early blackberries may be considered as giving a successful crop. What strawberries came were not worth picking, as the frosts of the 13th to the 17th of June destroyed most of the buds and young fruit. The orchard was heavy with bloom, but with the exception of one-half pint of Early Richmond cherries none of the fruit matured. The grape vines contained considerable green fruit and the Concord and Delawares were just beginning to ripen when caught by the frost.

Along the line of improvements there has been a 6-ton wagon- and stock-scale put in, a 16 ft. x 32 ft. one story feeding-barn built, an acre sheep-lot fenced, and the necessary corrals for the feeding experiments put up.

Live stock purchased consists of one team of horses, one ram and two ewes of the Rambouillet Merino strain. For the feeding experiments, three ewes, three lambs, and six head of range steers.

Implements purchased consist of one fanning-mill, one pair Fairbanks platform scales, one 6-ton wagon- and stock-scales, one Star feed-grinding mill, and one Banner root-cutter.

The feeding experiment on sheep commenced December 1st, and on cattle December 16th.

The following sales were made from the Farm: Grain \$21.75, Alfalfa Seed \$20.00, Potatoes \$6.00, Blackberries and Raspberries \$44.00, Currants and Gooseberries \$9.00. Total, \$100.75.

SHERIDAN EXPERIMENT FARM.

J. F. LEWIS, SUPERINTENDENT.

have the honor of reporting for the season of 1895, has been unfavorable for many kinds of crops.

A large amount of rain fell during the spring months, when the dry weather came so much alkali came to the surface on the lower part of the farm that many crops were injured and some entirely burned up. One hundred and fifty rods of drain ditch was constructed during the winter to drain this part of the farm, which I think will be a great benefit, as the water does not stand on the surface as it formerly did. If we have a great amount of rain and I think the most of the alkali will be washed out by the spring time in the spring.

The special tests with potatoes and other crops have been a success generally.

The instructions in regard to the flat pea were carried out and I think it may become a valuable forage crop in the future, especially if it can be grown without irrigation. The plants have proved a failure in every respect, and I would pronounce it a humbug. All of the oats were badly affected with smut on the farm as well as in the country generally.

Both alfalfa and clover did extra well. All of the experiments where the crops did not interfere have been fairly successful and the farm is in good condition for next season's work.

Fruits of all kinds have been given winter protection. Trees mulched with stable manure, strawberries with

loose straw and raspberries and blackberries plowed under.

Improvements made have been a fence around the orchard, to prevent stock from injuring fruit trees in the winter time, and a hollow-walled brick cellar. The house and barn are in good repair; the former badly needs painting, however.

The farmers seem to be taking a much greater interest in the farm. Many farmers as well as strangers have been received and shown over the farm, and apparently place much reliance upon our results.

SUNDANCE EXPERIMENT FARM.

A. E. HOYT, SUPERINTENDENT.

In conformity with instructions, I transmit, herewith, the Annual Crop Report, together with the Permanent Crop Record and Field Notes of the Sundance Experiment Farm for the season of 1895.

The spring was unusually backward, and the growth of all things at the beginning was retarded by the low temperature and cold rains.

The total precipitation during the four months of April, May, June and July was 10.95 inches, distributed as follows: April 2.28, May 2.97, June 5.25, and July .45 inches. It was amply sufficient in each month except July, when much damage was done by drouth, especially to small grain.

The mean average temperature for the four months referred to was as follows: April 46.1, May 48.6, June 57.1, July 64.3. The mean average for May was very low.

Plans of Experiments for 1895" were followed and carried out as closely as circumstances and conditions rendered possible.

This was the second year of the potato experiment, the results being given in the Crop Report.

Much of the small grain contained a large amount of

Observations of practical farmers, extending over several years, seem to prove that "volunteer grain", in this country, is wholly devoid of smut. This would indicate that growing of small grain would produce a smutless product. To test this, I caused to be planted on the farm in November, two and one-half acres of small grain. One acre is planted to wheat of smutty seed, one acre to corn of pure seed; and one acre to oats of pure seed. Being all spring grain, it was planted so late that it did not germinate until next spring.

Apple proved an entire failure, notwithstanding that special instructions relative thereto were closely followed and every precaution taken to insure and promote its success.

The late spring frosts wholly destroyed the blossoms of the apple, plum and pear trees, and greatly injured them on the crabs. Many of the latter, however, bore fruit of good size and excellent quality. Two hundred and twenty-seven apple trees, and one hundred and twenty-three pear trees from a Colorado nursery were planted this year. The trees were two years old "cut back". Some showed a growth of thirty-five inches, and the average growth of all for the season was about twenty inches, which was considered phenomenal, and a proof of the superiority of

the "cut back" tree. Small fruits flourished abundantly, the Crandall variety of currant being especially prolific.

Experiments with corn were not so successful as in 1894, when all varieties matured, and produced good yields. Results achieved during the existence of the farm demonstrate that corn can be successfully grown (except in an unfavorable season such as the last) in most parts of Crook County when sufficient care is given to varieties and to seed.

Brome grass and Esparsette thrive best of the grasses. The former is especially adapted to this country, and the seed is much sought after by our farmers. Every effort is being made by the management to supply this demand.

A report of results derived from seeds furnished by the U. S. Department of Agriculture accompanies this report on separate blanks furnished by the Department, in addition to being incorporated in the main report, and in the Crop Record Book.

The new forage plant "Sacaline" was given a trial for the first time. It appears to have been a failure wherever tried in this county.

The roller was freely used on small grain when from one to three inches high. The process is especially valuable in dry seasons, as it tends to retard evaporation.

The farm is well supplied with agricultural implements of modern make and style.

During the year \$34.15 have been realized from the sale of wheat, corn and hay grown on the farm.

Much of the farm has been in cultivation for over ten years with but little fertilizing, and as a result has become worn out. It is recommended by the management that

ats be sown to red clover, alfalfa, crimson clover, or good fertilizers, during the season of 1896. is recommended and urged that but little space and n be given to vegetables hereafter. The time d in their cultivation is largely taken from that should be given to more important matters—notably y, which is now becoming an important feature of m work.

WHEATLAND EXPERIMENT FARM.

M. R. JOHNSTON, SUPERINTENDENT.

herewith submit the Annual Report of the Wheat-
Experiment Farm for the season of 1895.

ork was commenced on March 1st, two men being ed, one man working eight, and the other eight and f months during the season.

ne planting and sowing was started during the latter March. Owing to the exceedingly fine condition il was in, crops were started with most favorable cts. Seeds of all kinds that were planted during nd the fore part of May came up and thrived well art to finish. During the latter part of May and the rt of June we had an unusual amount of cold, wet r, which had a tendency to rot many of the seeds ere planted late.

ur experiment this season with alfalfa as a fertilizer I has proved a success from a financial standpoint. ed was planted this spring. One crop of hay was ed, which would about pay for seed and cultivation,

as well as plowing under the second crop—which made good growth—for fertilizer.

Spring wheat, rye and barley all made first-class showing.

Winter wheat proved a failure.

Winter rye did well.

Of the oats tried, three varieties did well. The other varieties were badly affected with smut.

Corn and potatoes did fairly well; yield medium and quality fair.

Vegetables of all kinds made fair showing.

Among the small fruits, strawberries were a failure; owing altogether, I think, to the locality in which the beds were planted. On May 20th the crop was pronounced a failure. Plants were transplanted to a more favorable and protected plat.

Several varieties of blackberries and raspberries fruited fairly well.

Gooseberries and currants both proved a success.

Fruit and ornamental trees of all kinds have made splendid growth, and are all going into the winter in good condition.

Several varieties of plums and cherries, that were planted in 1892, bore fruit.

With the exception of one or two varieties, the small fruit trees that were planted in the nursery this spring have done surprisingly well, making good growth and looking thrifty at date of mulching.

The seed that was planted in the nursery proved a failure.

No improvements were made on the farm this season.

all amount, however, has been expended to keep the
ings and implements in repair.

At the end of the season's work tools of all kinds
carefully cleaned, oiled and stored. Seeds of all kinds
labelled and arranged for use next season. The fen-
ere given the necessary repairs.

As yet, very little of the crops raised on the farm has
disposed of, owing principally to the surplus raised in
locality, and the extremely low prices.

PRESS BULLETINS.

In addition to the regular Bulletins issued by the Experiment Station, and made a part of this report, as found in the Appendix, we have issued the following Press Bulletins: No. 1, "The Russian Thistle"; No. 2, "Seed Distribution"; and No. 3, "Sacaline as a Forage Plant."

Copies of these Press Bulletins were sent to the various papers of the State for publication, thus reaching a large number of our citizens interested in the general knowledge contained in the Bulletins. I deem these Press Bulletins of sufficient importance to reprint them in this Annual Report, so that they may be made a matter of permanent record.

The Russian Thistle.

This Pest is Invading the State of Wyoming.

(Bulletin by the State Experiment Station Botanist.)

Recently the Russian thistle has been reported from one and once also from Rawlins, but so far as known no other locality in the State. From an undoubted source received from Mr. F. J. Stanton of Cheyenne it is known that it has invaded the State and that, unless some precautionary measures are taken, we shall have this State overrun by it as are already some of our neighboring

introduced into the United States in South Dakota in 1874 at first, on account of the lay of the land, spread slowly, but since 1888 it has spread with alarming rapidity. It is now found more or less generally distributed in those States lying between the Mississippi River and the base of the Rocky Mountains, and north of the southern boundary of Nebraska. So rapid has been its spread and so detrimental to agricultural interests that the infested States have called for a special investigation of the subject. In response to this demand the U. S. Department of Agriculture has sent out special agents to inquire into its prevalence and the best means of combatting it. The results of this investigation have been published in Bulletin No. 15 of the Department of Botany, which is a valuable discussion of the history, distribution and means of eradicating the weed. It is probably to be obtained by addressing the Department at Washington.

Not to enter into the botanical history of the plant, I will only state that it is not a thistle, being called so only on account of its spines. It is known botanically as *Salsola kali tragus*, and is allied to the "pigweeds", but most closely resembles the common western "tumble weed" (*Amaranthus albus*). "When not quite mature the whole plant has a reddish color, but as its seeds ripen it bleaches out and eventually is almost white." "Each twig and branch is covered on all sides by hard, stout prickles, which are very sharp and very irritating to the touch." "These prickles are in threes; that is, there are three together in a place and pointing in different directions." At the upper side of the base of each three prickles there is a seed, and as the plant branches very freely and is often two to three feet across, a single plant may produce thousands of seeds. When mature the wind breaks it off at the root, and its compact and nearly spherical form causes it to be driven by the wind hither and yon, over field and plain, scattering its seed as it goes. This has given it its other common names, "Russian tumble weed" and "Leap-the-fence".

This, then, is the plant that is said to crowd out other plants, to interfere with the operation of all farm machinery and to inflict by contact severe injury upon both man and beast.

The conditions of its growth are found almost everywhere. It does not, however, usually grow in wet swamps nor on well-sodded ground, but it may be looked for wherever the ground is broken in any way. Along highways, on railroad embankments, in waste places and in fallow and cultivated fields it finds the conditions for its best development. In soils too dry or too heavily impregnated with alkali or other salts for the development of the useful crops the "Russian thistle" yet makes a fair growth and matures and distributes its seed. This being so, Wyoming, with its dry alkaline soil, offers to this weed nearly the same conditions as do those parts of Russia that have been nearly

over to it. The object of this bulletin is to urge that be taken to prevent such a dire result in Wyoming. s a case where "An ounce of prevention is worth a l of cure." Probably there are only as yet a few in the State, and these along the several railroad

The principal agencies for the distribution of the are the stock cars, grains, seeds and hay from the ed localities, and the wind, before which it travels for

f farmers and ranchmen and road commissioners will out for it and destroy all suspected plants, by cutting en, by burning if mature, and if all railway lines will at the same is done on their rights-of-way, as I learn nion Pacific is doing, we shall be spared the trouble, jury and the loss that our sister States are undergo-

The Dakotas, Minnesota, Wisconsin, Illinois, Iowa,aska and Colorado are fighting it with all available s. Several of these States have enacted laws looking destruction, as well as that of other obnoxious weeds. espectfully suggested to the law-makers of Wyoming uch a law is opportune for this State, and would be effective now than when the whole State has been in- . Attention is called to the weed laws of Wisconsin e Dakotas, which may be suggestive as models.

* * * * *
Correspondence relating to the "Russian thistle", its lence, etc., is solicited from every part of the State. of suspected plants may be sent by mail for determin-

Other noxious weeds will also cheerfully be determ-

Address

AVEN NELSON, Botanist,
Agricultural Experiment Station,
Laramie, Wyo.

Seed Distribution.

By an Act of the recent Congress the distribution of seeds by the Department of Agriculture, heretofore distributed by members of Congress, will hereafter be distributed in the various States by the Agricultural Experiment Stations.

Some seven hundred packages of seeds, containing about thirty varieties in each set, will be sent to the Wyoming Agricultural Experiment Station for distribution in the State. These seeds are to be used in a "Co-Operative Seed Test" as to varieties, for 1895, on conditions imposed by the Department of Agriculture at Washington. These conditions are (1) that the ranchmen and farmers receiving the same will plant and cultivate the seeds according to instructions furnished by the Experiment Station; (2) that at the close of the season a report of each variety will be made on blanks furnished by the Department of Agriculture.

These sets of seeds will be sent to such farmers and ranchmen in the State as request the same, and will agree to use the seeds on the conditions above stated. The farmers and ranchmen requesting these seeds are expected to pay the expressage or postage on the same. Applicants for seed will please enclose postage, or request the seed to be sent by express, so that they can pay charges on receipt of the same.

Parties desiring to join in this co-operative seed test in Wyoming are requested to inform me at once.

A stylized, handwritten signature in dark ink, appearing to read "A. A. Johnson". The signature is enclosed within a large, circular, loopy flourish that starts under the first letter and ends under the last.

Director.

Wyoming Agricultural Experiment Station,
Laramie, Wyo.

Sacaline.

(Polygonum Sacalinense.

Early last spring, through the local papers, we advised farmers and ranchmen of Wyoming not to purchase or plants of sacaline until its value could be determined by the Experiment Station.

The plant has been so thoroughly advertised and such extravagant statements have been made of its hardiness, activeness and value as a forage plant, that we believe a farmer should be advised of our results in growing it. A pound of seed and twenty roots were purchased of A. & Co., Philadelphia, for each Experiment Farm. They have been given a careful trial in each place. At Sheridan the roots were planted in pots in the greenhouse in order to give them a good start before setting them out in the field. These made small growth and though kept in the glass they died down to the ground at the end of a few months. At Sheridan, sixty-one plants came up from seeds by the middle of August, the tallest reaching a height of eight inches. None of the seed grew at the other places and at no place did plants from the roots reach a height of more than twenty-six inches. In short, our results indicate that sacaline is not sufficiently hardy to be of practical value in any part of the State. According to reports, it has failed in Colorado, Kansas, New Mexico and Texas.

However, in reporting our results, we would mention the fact that the seed of another species of knotweed, (*Polygonum cuspidatum*,) is sometimes sold for true sacaline, and we are not sure that our seed and roots were not of this variety. In fact, measurements of leaves on plants at Sheridan would indicate that they are "false sacaline." Whether we have grown the true sacaline or not, we believe that any attempt to grow it will result only in loss of time and money.

A circular from the Department of Agriculture on sacaline, by Lamson Scribner, says:

"From the native station of the plant, along moist river banks, upon an island with a cold and very moist climate—and from the recommendations as to its culture by horticulturists who have had experience in growing the plant, it is very doubtful if it will prove a success in the arid regions of the West; in fact it seems hardly probable that it can grow there at all."

B. C. BUFFUM,
Prof. Agriculture and Horticulture,
Wyoming Experiment Station.

APPENDIX.

UNIVERSITY OF WYOMING.

Agricultural College Department.

oming Experiment Station,

LARAMIE, WYOMING.

BULLETIN NO. 21.

JANUARY, 1895.

GRAIN SMUTS AND POTATO SCAB.

BY THE BOTANIST.

etins will be sent free upon request. Address: Director Ex-
t Station, Laramie, Wyo.

THE A. A. BROS. CO., PRINTERS AND BINDERS, CHEYENNE, WYO.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

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THE HORTICULTURIST IN CHARGE,		WYOMING UNIVERSITY EXPERIMENT GROUNDS

SPECIMENS WANTED.

Specimens of cultivated plants of all kinds if found aff-
ected with fungi are particularly desired and all available
information concerning the same will be furnished to the
collector on request. We would also like to receive, from all
parts of the State, information concerning and specimens of
undesired weeds.

Plants of any kind will be cheerfully determined for the
collector. All such specimens may be sent by mail.
If there are those in the State who would like to secure
determination of their local flora in whole or in part they
please write for directions for collecting.

Address all samples and correspondence to

THE BOTANICAL DEPARTMENT,
Agricultural Experiment Station,
Laramie, Wyo.

ne Grain Smuts and Potato Scab.

AVEN NELSON.

GENERAL OBSERVATIONS.

is only recently that Wyoming has come to be recorded as one of the agricultural States. Even after fertile fields had been opened and bountiful crops ofables and grain had been harvested, after flouring mills been established and were grinding the plump grain into the best of flour, we still continued to think of Wyoming as a State of boundless possibilities because of her resources and as a fit place for the grazing of the herds that roamed over her hills and plains. Slowly but recently more rapidly the valleys and plains have been dotted with the homes of those who, seeking for a where their toil should have greater reward than the crowded communities of the East could offer, found in our sunny slopes and in our smiling valleys with life-giving streams the conditions they had sought. With them they brought the habits and methods of the agricultural communities from which they had emigrated. The immense hay and stock ranches are still here, besides these there are many small farms and small herds under the personal supervision of the owner which are doing more for Wyoming's material advancement than was possible under the former conditions.

Under the old conditions there was neither demand nor necessity for agricultural information. Success in the cattle business depended upon such natural causes as the rainfall, the snowfall, the severity of the winter, and upon the trustworthiness and faithfulness of the foreman and helpers of the ranch.

With the introduction of the farm, here as elsewhere, arises a demand for such information as will aid in controlling and guiding the forces of nature. One's power to do this makes the difference between success and failure, between prosperity and poverty.

But with the introduction of farming and the importation of seed into the State some at least of the evils with which the farmer of the East has to contend have found their way into our agricultural communities. Weeds are beginning to be a serious trouble and fungi are causing increasingly greater annual losses. This being the case no apology need be made for the dissemination of any information that will aid in securing to the husbandman the fullest return for his labor.

THE NATURE OF FUNGI.

As those whose reading has not been along botanical lines have very vague notions as to the nature of fungi and the relation of the same to plant diseases, it may be well to briefly recite their characteristics.

In the first place, then, fungi are plants of rather simple structure. They consist essentially of a plant body or vegetative part, the mycelium, which is made up of one to many very slender, usually microscopically small threads or filaments, and certain reproductive bodies known as spores.

latter are produced either directly on modified ends of the filaments or in specially formed receptacles usually named according to the place and manner of formation. The spore is not a seed but is analogous to it in that it is able to perpetuate the plant. Spores are in most cases exceedingly small and light that they may, unknown to us, be blown about by the wind in vast numbers. As a rule they have great vitality and will resist very unfavorable conditions of heat and moisture, but germinate promptly when favorable conditions are offered. Fungi differ from plants in that by reason of the lack of leaf-green (chlorophyll) they cannot prepare (elaborate) their own food. Though preparing nothing they are vigorous feeders and help themselves freely to the products previously prepared by other plants or animals. If they live upon dead organic matter they are known as saprophytic fungi. Such are mushrooms, toadstools, etc. If they live upon other living plants they are called

PARASITIC FUNGI.

The parasitic fungi are the cause of a very large part of the diseases that lay waste our gardens, orchards and fields. In various ways the spores are distributed and find entrance upon the tissues of other living plants which are called the hosts. Here the spores begin to germinate, and they begin to grow by sending out slender threads (hyphae) which penetrate into the tissue of the host or creep along the surface and in either case extract the nutritive material from the adjoining cells. This is done either directly or by means of special bodies, modified branches, which penetrate into the adjoining cells and are known as haustoria. These plants then are seen to be simply robbers, living

upon the products of others' toil, and were there only a few they would probably but slightly affect the plant and might escape our notice; but by reason of their rapid growth and multiplication they often completely drain the host of its prepared food or smother it, thus causing its fruitlessness or death.

FORMER OPINIONS.

Very erroneous ideas formerly prevailed in regard to the plant diseases designated as blights, mildews, rusts, smuts, etc. They were variously attributed to "the wet weather", "the hot weather", "the unfavorable weather", and other like indefinite causes. The injuries inflicted were considered as mere degeneration or decomposition of the tissues of the plant due to a diseased condition caused by unfavorable weather. It is now positively known, however, that these diseases are caused directly by fungal plants, and that these latter never arise spontaneously, but always from similar plants or their reproductive bodies. Fungi like other plants thrive best under certain climatic conditions to which they have become adapted, and it does not necessarily follow that these conditions are unfavorable to other plants, except in so far as they become a prey to fungi developing under like conditions. Now it happens that the rusts and mildews are propagated and distributed most rapidly during wet and hot seasons or during that part of the season when those conditions prevail. On that account, Wyoming may hope to escape all serious invasions of the above fungi which live upon the host plant, rather than within its tissues. As the whole of the State lies within the arid belt, very few sections, if any, being entirely independent of irrigation, and as the altitude of even the lowest

State is considerable, it is not likely that any season ever those optimum conditions for the development of viz: wet and hot weather at the same time. But this only to those fungi that attack growing plants; those spores are distributed by the wind and are capable of actively infecting new plants and new fields. The spores must not only have heat and moisture before they germinate freely, but must be able to force their hyphae through the cutinized epidermis of the leaf or stem and thus bring themselves in contact with the nutritive tissues of the plant. And here I think we find an additional safeguard, namely, that it is probable that plants growing in this dry atmosphere produce a more heavily cutinized epidermis than do plants growing in a moister climate. This adapts and enables them to more fully protect themselves against the loss of water from their tissues. But this applies only in those cases where many fungi penetrate into the interior of the host plant through the leaf pores (stomata.) Experience has shown, however, that we are no more successful in other states from such plant diseases as result from infected or spore covered seed. This includes our most serious plant diseases, the grain smuts and potato

THE GRAIN SMUTS.

THE EXTENT OF INJURY.

There is a general lack of appreciation of the injury caused by these diseases except in cases where almost or quite a total failure of the crop occurs. Then the victim bewails his loss and looks about for a remedy. The loss of one, five or even fifteen per cent of the crop remains unremarked although it may make the difference between profitable and non-profitable farming.

From correspondence with men in different parts of the State, I am convinced that there were very few fields, if any, that last season entirely escaped some loss by reason of smut in wheat and oats, although in nearly every instance this disease was reported less destructive than during former years. Notwithstanding that the loss was smaller than usual, different localities reported losses amounting in some instances to one-third of the crop. From this maximum the per cent. of loss ranged down to one. In the minds of some of my correspondents this latter loss, apparently, was considered very trivial, too small in fact to be worthy of attention. It may be noted here, however, that especially if the loss is small the tendency is to underestimate it, for the smutted heads maturing a little earlier than the healthy grain are by harvest-time stripped of their contents by the wind and only the inconspicuous stalks remain.

It may enable us to form an idea of the unnecessary losses we each year sustain to know that a careful estimate of the loss through smut in wheat and oats in Michigan* in 1892 was placed at \$1,000,000. This was considered a low estimate and that too with a percentage of loss no greater than is the case in this State.

SUCCESSFUL PREVENTIVE TREATMENT.

There is no longer any doubt about the successful prevention of these diseases by proper treatment. The remedies suggested are not founded on theories but on the facts of repeated experiments, and on several years of successful application in different parts of the world. The character and nature of these fungi are known and the treatment necessary for their extermination fully established.

*Experiment Station, Bulletin No. 87.

INFECTION AND GROWTH.

The manner of infection and growth is essentially the same in all the smuts. Rarely if ever does the smut fungus find entrance into the grain except during the germination of the grain seed. No danger need be apprehended from the source except from spores introduced into the soil with the seed or from already infected soil, straw and fresh manure brought into contact with it. If the field of grain from which the seed was obtained was infected the threshing of the same would distribute the spores throughout the threshed grain. When any of this grain is used as seed and sown in moist soil the germination of the adherent fungus follows closely upon the germination of the grain itself. Only those spores that lie very near the germ end of the grain are likely to effect an entrance into the growing grain, but once they penetrate they continue to grow as the grain grows, passing up through the tissues of the stem, and less filling them, but not fruiting until the host begins to fruit. When the host plant begins to form its reproductive bodies, the ovules, the fungus occupies these or the protecting husks of the same, or both, with its hyphæ, on the branches of which are produced large masses of the black or black spores.

THE SMUT OF OATS. [*Ustilago avenæ* (Pers.) Jensen.]

In this smut not only the grains but the husks are covered by the black powdery masses of spores. In this smut as in the other kinds of smuts there is no indication of the presence until the grain begins to head unless it be that the diseased stalks are slightly smaller and less thrifty. The general appearance of this form of smut is indicated in the illustration. It is unlike the following kind in this, that it does



Fig. 1.

Loose Smut of Oats: a. The smut spores; b. A completely smutted head; c. A similar head as it appears at harvest-time; d. A head only partially smutted. [a. greatly enlarged, b, c and d about natural size.]

ersist in the head and may all be blown away by harrow.

STINKING SMUT OF WHEAT. [*Tilletia foetens* (B. & C.) Shroet.]

In this smut only the interior of the kernels of the grain is occupied by the spores. The heads except on close examination appear nearly normal, and not till the kernels are

broken in the hand one realizes that they are filled only with masses of dark brown spores. These are moist or slightly wet and give forth a very disagreeable odor. This is a test for a test of the presence of this smut whose general appearance is shown in

Wheat is subject to the other kind of smut which in general appearance closely resembles the loose or loose smut of oats and is known as the loose smut of wheat. [*Ustilago tritici* (Pers.) Jenkinson]. Like the loose smut of oats this is

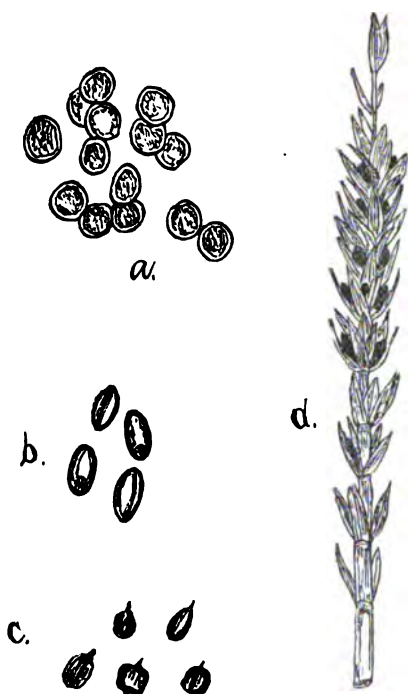


FIG. 2. Stinking Smut of Wheat: a, The smut spores; b, Sound wheat grains; c, Smutted wheat grains of different shapes; d, A badly smutted head as it appears when harvested. [a, very greatly magnified, b, c and d about natural size. The grains as represented in d, are too dark.]

odorless and occupies the husks as well as the grains and may all be blown away before harvest. For this smut no very effective remedy is known, but as it is far less common and destructive here than the other a remedy for it is not so important as an effective one for the prevention of the stinking smut of wheat and the loose smut of oats.

MEANS OF PREVENTION.

All means proposed for the prevention of smuts have for their object the killing of the smut spores adherent to the seed grain. If this is accomplished without injury to the germ contained in the seed you may expect a crop free from smut unless the soil contains smut spores from the previous crop or they are introduced with freshly applied manures. Several methods have been practiced with some degree of success, but only two have proven completely effective. Probably the better of these two methods is the one known as

THE JENSEN, OR HOT WATER TREATMENT.

This method is applicable to both oats and wheat smut and has the advantage of being cheap, easily applied, safe and effective.

It originated with J. L. Jensen of Denmark in 1887. He discovered that water of sufficient heat to kill the spores of the smut did not injure the seed grain but rather improved its germinating power and increased the yield. This method has been repeatedly tested in all parts of the world and has always proven effective where the proper precautions have been observed. It consists simply in immersing the seed, which is to be freed from smut, in water of such a temperature and for such a time as will be fatal to the smut

s. It has been found that water whose temperature is 135 deg. F. or above will kill the spores if they are subjected for some minutes. On the other hand the temperature of the water must not rise above 135 deg. F. nor must the treatment be continued much beyond fifteen minutes, otherwise the germinating power of the seed will be injured or destroyed. Various contrivances for carrying out this treatment have been suggested, but the procedure briefly indicated below indicates the usual practice.

METHOD OF PROCEDURE.

Provide the following necessities, viz: a loosely woven sack or, much better, a bushel basket lined or covered with fine meshed wire netting or a basket made wholly of wire netting. This is for holding the grain while it is being dipped. Next two large kettles, boilers or barrels to be filled with water into which the seed is to be dipped. Keep the water in the first between 110 and 130 degrees. That in the second as near 132½ as possible. Finally provide two other vessels, one for cold, the other for boiling water, either of which may be at hand for regulating the temperature of the water in the vessels into which the grain is to be dipped. The object of dipping the grain into the first vessel is to warm it so that when plunged into the second the temperature of the water in the second may not be greatly lowered. When everything is at hand proceed as follows: Place a bushel, more or less, of the grain to be treated into the bushel sack. Plunge it into the first vessel, raising and lowering and shaking it by alternate right and left movements till the grain is uniformly warmed. This should require less than a minute. Now raise and drain for a moment, then plunge into the second vessel, repeating the above move-

ments six to a dozen times in the course of twelve to fifteen minutes. Then raise, drain for a moment, and immediately cool by dashing cold water over it or by dipping it into the same, after which spread it out to dry.

The temperature of the water in the two vessels must be kept within the indicated limits, which can best be done in the case of kettles over a fire or boilers on a stove by the addition of cold water from time to time. If barrels are used a large kettle over a fire near by will furnish the hot water with which to keep up the temperature of the water in the barrels. Proceed in this manner till all the required seed is treated.

The process just given is particularly applicable to wheat but applies also to oats. However on account of the hulls which enclose the seeds of the latter, the following modifications have been found to be of advantage. Either have the water in the second vessel 140 to 143 degrees and immerse for only five minutes, cooling afterwards with cold water, or have the water at the usual temperature of 132½ and immerse for ten minutes, after which spread out to dry without first cooling with water.

If the seed is to be used at once it will soon be dry enough for sowing broadcast or from a force feed drill, but the drill must be set to feed more freely to compensate for the increased size of the grain. Wheat may be completely dried and stored again, but oats on account of its hulls is dried with difficulty.

PRECAUTIONS AND SUGGESTIONS.

1. Keep the water in the second vessel within the limits of 130 to 135 degrees.

- . See that every grain is subjected to water of this temperature.
- . Secure a reliable thermometer suitable for this use.
- . Let the quantity of water be ample.
- . Do not fill the basket so full that it cannot be deftly easily handled.
- . Do not return the treated seed into the same sacks or to other infected sacks without first scalding them.
- . Remember that infected bins, vessels, seeders and tools will again infect the seed if brought into contact.
- . Remember that the threshing machine, if just previously used elsewhere on smutty grain, will infect your seed and make treatment necessary.
- . Remember that you shall reap what you sow; if you sow smut you will reap more smut.

The second best treatment, and judging from my correspondence the only method known or ever used in the United States is

THE COPPER SULPHATE (BLUE STONE) TREATMENT.

This consists in treating the seed with a solution of copper sulphate. Two methods have been followed, viz: first, by using a strong solution of copper sulphate, say 1 pound to 5 gallons of water, immersing the seed in this for a few hours and then drying preparatory to use as seed. The second method consists in using a dilute solution, say 1 pound to 25 gallons of water, in which the seed is immersed for 24 hours. It is then transferred into lime-water (1 pound of good lime to 10 gallons of water) for only 5 to 10 hours and is then dried preparatory to sowing. The latter of these two ways is recommended as not likely to injure the seed, while it is as effective as the former, but

neither is as safe nor productive of as great gain as the Jensen method.

ADVANTAGE OF TREATING THE SEED.

Experiments at different stations and by many practical farmers have proven that the gain arising from treating the seed according to the Jensen method is not simply the saving of the grain that otherwise would have been smutted, but there is a gain over and beyond this due to the increased germinating power of the seed and increased thriftiness of the resulting crop. This latter gain is in itself sufficient to much more than pay for the time and trouble of treating the seed.

SUGGESTIVE AND PRACTICAL QUOTATIONS.*

†1. "Stinking smut is one of the most destructive diseases to which the wheat crop is subjected."

"Do not follow smutted wheat with wheat again for one or better for two years."

‡2. "It is a fair estimate based on counts in many parts of the Union to estimate the net gain to be obtained by treating seed oats, at 8 per cent. of the crop obtained. Since the aggregate value of the oat crop of the United States from 1880 to 1890 was \$2,030,712,605, the net gain from a universal system of seed treatment would have been \$162,457,008.40 for those years."

*In the preparation of this Bulletin I have drawn freely upon the facts as given by other botanists and station workers, but as the facts have now become public property and as the language and arrangement is my own I find it impracticable to give more than this general acknowledgment.

†Dr. J. C. Arthur, Bulletin No. 28, Indiana.

‡Prof. W. T. Swingle, Farmers' Bulletin No. 5, U. S. Dept. of Agr.

3 "It has been demonstrated over and over again perfectly clean seed and clean ground will produce a crop. It is with smut as with weeds of all sorts, if we have seeds we shall have weeds growing up as a result, if we have no seeds there will be no weeds. So with Clean seed upon a clean field will result in a clean

ANOTHER METHOD.

the Journal of Mycology, Vol. VII., No. 4, recently I find given by B. T. Galloway, Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture, a new method for the application of the Jensen treatment. By it one can treat large quantities of seed in less time and with less labor than by the old method. As there may be those in the State to whom it is of service I take the liberty of quoting it in full.

During the past year Mr. Elam Bartholomew, of Fort Scott, Kans., a special agent of the Division, made some interesting experiments in the treatment of oat smut by the hot-water process. Among other things, Mr. Bartholomew devised a method for treating large quantities of grain without resorting to the tedious basket-dipping process. The latter, he says, will answer fairly well for a few bushels of grain, but where a large acreage is to be treated the labor involved and the general inconvenience of the work will prevent many farmers from adopting the method. Mr. Bartholomew's method of treating five bushels of grain at a time was essentially as follows:

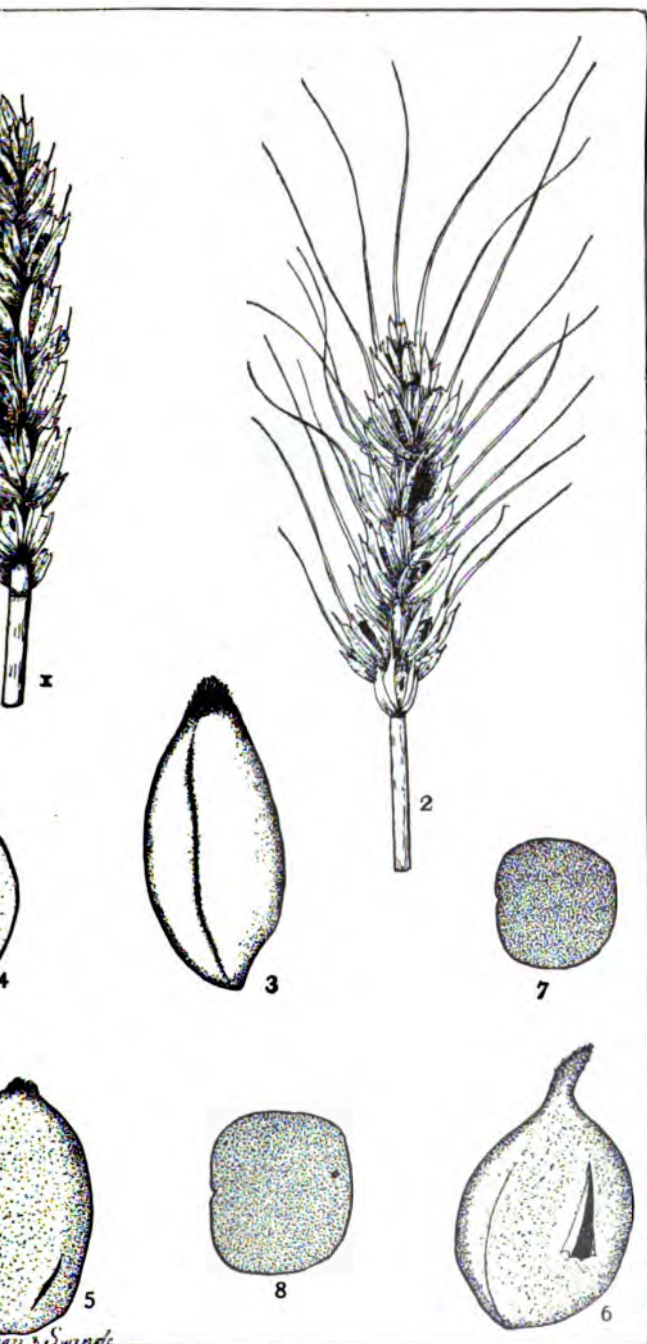
A common kerosene barrel was procured, and after removing the head a 1 1/2-inch hole was bored in the bottom to the rim. The hole was then covered with a piece of window screen, the latter being tacked to the bottom of the barrel on the inside. A pine plug was then fitted

Dr. Chas. E. Bessey.

to the hole from the outside in such a way that the end barely reached the fine wire screening. After making these preparations the barrel was placed on a box high enough to allow a pail or tub to be slipped under the bung. An old well bucket, such as are used in bored wells, was then obtained, and after removing the bottom, four rows of half-inch holes, running the entire length of the bucket, were punched, as nearly as possible the same distance apart, six being placed in a row, making twenty-four in all. After punching the holes the bucket was placed in the center of the barrel, bottom end up, and resting on its bail, thereby raising it four or five inches from the bottom of the barrel and causing it to project a little above the top of the latter.

Holding the bucket in position, five bushels of badly smutted oats were emptied into the barrel. There were already on hand a common wash boiler and an iron pot filled with water which had been heated to boiling point on the cook stove. The contents of the two vessels were cooled to 130 degrees F. by the addition of cold water, thereby increasing the quantity of the liquid to fifteen gallons. This was then poured into the bucket in the center of the barrel until all the grain was covered. The floating grain was pushed under with the hand and the barrel covered with a cloth to hold in the heat. After standing ten minutes the water was drawn off through the hole at the bottom of the barrel, the temperature in the meantime having fallen to 100 degrees F. More boiling water was added to the water drawn off, until the temperature reached 133 degrees F., when the liquid was again poured into the barrel and allowed to stand ten minutes, as before. Again the drawing off and heating process was repeated, the water being poured back into the barrel and allowed to stand ten minutes. It was then drawn off for the last time and a new lot of grain put in and treated as in the first case.

Mr. Bartholomew says that seed treated in this way yielded less than one-tenth of one per cent. of smutted oats, while in fields where no treatments were made twenty per



g Smut of Wheat: 1 and 2. smutted heads of beardless and bearded wheat
 3, sound grain of wheat; 4, same in cross-section; 5 and 6. smutted grains;
 e in cross-section. [1 and 2 natural size; the others somewhat enlarged.]
 We are permitted to present the above excellent plate through the courtesy
 of the Kansas Experiment Station.

cent. is often affected with the fungus. A piece of 6-inch stovepipe, it is thought, will answer the same purpose as the bucket. The pipe should be arranged so that it will stand at least four inches above the bottom of the barrel."



Fig. 3.

POTATO SCAB.

There is no one crop in Wyoming of so much promise and importance as the potato crop. It can be grown with almost absolute certainty and experience shows with great profit, and that too in all parts of the State. The enormous yield and fine quality have won for Wyoming potatoes during 1894 and previous years several prizes against all competitors. The experiments on the different Experiment Farms of the State show that the crop can be produced with a minimum of expense and labor. It is therefore important that steps be taken to preserve these conditions by keeping out of the State, as far as possible, the diseases to

the potato is subject. The one most to be feared by
the

POTATO SCAB. (*Oospora scabies* Thaxter.)

This is a wholly preventable fungous disease and never
in clean soil unless the germs are introduced with
seed. The cause, means of infection and distribution of
the disease have been worked out by others,* and it is my
purpose to merely state briefly the means for its preven-

tion. It needs no description for it is becoming entirely too
common. It is identical with the beet scab, the treat-
ment for which is the same. The importance of treating
seed cannot be put too strongly, for not only does the
disease injure the sale of the crop but it greatly reduces the
yield. More than that, the fungus once introduced into the
soil persists in the soil for a number of years. The writer
has long evidence that even five years will not eliminate
the fungus from the soil if once introduced. Seed apparently clean
planted in 1894 on ground that had been fallow for five
years but that previous to that time had for several years
produced scabby potatoes. The crop of 1894 was almost
entirely scabby. As the seed used was not treated this
conclusion is not conclusive, but it is not likely that seed
apparently clean would have infected the whole crop. It is
advisable, at least, that it is not safe to follow a crop of scabby
potatoes with potatoes again. How many years the ground

*Prof. Bolley, N. D. Exp. Station, Fargo, N. Dak., Bulletins Nos.

1 and 2. Thaxter, Conn. Station, New Haven, Conn., Report 1890.

*Prof. Kinney, R. I. Exp. Station, Kingston, R. I., Bulletins Nos.

1 and 2. Prof. Piper, Wash. Exp. Station, Pullman, Wash., Bulletin No. 8.

must be used for other crops before potatoes may again be safely grown in it, is not yet settled. In this State where the soils are mostly yet new and free from the fungus, it will pay to keep them so by careful treatment of all scabby or even suspected seed. It is well to remember that even perfectly smooth tubers may be infected, if they have been in contact with scabby potatoes in the bin or elsewhere. In the selection of seed, if possible, secure seed known to be free from scab.

TREATMENT.

In about fifteen gallons of water dissolve two ounces of corrosive sublimate, (bichloride of mercury). In this solution immerse the seed potatoes for one and a half hours, after which spread them out to dry, then cut and plant as usual.

CAUTION. If taken internally corrosive sublimate is a violent poison, hence all animals must be kept away from the solution and the treated seed. On account of its action on metals the solution must be prepared in wooden vessels, a barrel, for instance. See that the potatoes are clean. Put them into a coarse gunny-sack and place it in the solution. The vessels and all objects in contact with this poisonous solution must be destroyed or thoroughly cleaned.



List of Bulletins and Annual Reports by the Agricultural Experiment Station. May 1, 1891, to March 1, 1895. Laramie, Wyo.

BULLETIN No. 1—May, 1891. The Organization and the Proposed Work of the Station. D. McLaren, Director.

- * " No. 2—August, 1891. Plant Lice. F. J. Niswander, Entomologist.
- * " No. 3—November, 1891. The Sugar Beet in Wyoming. D. McLaren, Agriculturist, and E. E. Slosson, Chemist.
- * " No. 4—December, 1891. Meteorology for 1891. B. C. Buffum, Meteorologist.

FIRST ANNUAL REPORT, 1891.

General Statement regarding Station Work with Bulletins Nos. 1 to 4 inclusive. D. McLaren, Director.

BULLETIN No. 5—February, 1892. Best Varieties and Breeds for Wyoming. D. McLaren, Agriculturist, and B. C. Buffum, Horticulturist.

† " No. 6—May, 1892. Soils of the Agricultural Experiment Farms. Relation of Geology and the Chemistry of Soils to Agriculture. J. D. Conley, Geologist; Analysis of the Soils of Wyoming Station Farms. E. E. Slosson, Chemist.

" No. 7—July, 1892. Insecticides. F. J. Niswander, Entomologist.

† " No. 8—October, 1892. Irrigation and Duty of Water. B. C. Buffum, Horticulturist.

† " No. 9—December, 1892. Sugar Beets in Wyoming in 1892. E. E. Slosson, Chemist.

" No. 10—December, 1892. Meteorology of Wyoming in 1892. B. C. Buffum, Meteorologist.

†SECOND ANNUAL REPORT, 1892.

General Statements, with Bulletins Nos. 5 to 10. A. A. Johnson, Director.

BULLETIN No. 11—February, 1893. Crop Report for 1892. A. A. Johnson, Director, and F. J. Niswander, Superintendent Laramie Farm.

" No. 12—April, 1893. Ground Squirrels (Gophers). F. J. Niswander, Entomologist.

† " No. 13—July, 1893. The Feeding and Management of Cattle. W. A. Henry, Ph. D., University of Wisconsin. (Reprint by permission.)

" No. 14—October, 1893. Geology of the Wyoming Experiment Farms, and Notes on the Mineral Resources of the State. W. C. Knight, Geologist.

" No. 15—December, 1893. The Winter-Killing of Trees and Shrubs. Aven Nelson, Botanist.

" No. 16—December, 1893. Grasses and Forage Plants. B. C. Buffum, Horticulturist.

†THIRD ANNUAL REPORT, 1893.

Progress of Station Work, with Bulletins Nos. 11 to 16. A. A. Johnson, Director.

BULLETIN No. 17—March, 1894. I. Crop Report for 1893. II. Cost and Profit of Growing Wheat. III. Sugar Beets. IV. Garden Vegetables and Tobacco. V. Meteorology for 1893. B. C. Buffum, Horticulturist, and E. E. Slosson, Chemist.

" No. 18—June, 1894. I. Reclamation of Arid Lands. II. The Harver Water Motor. A. A. Johnson, Director.

" No. 19—September, 1894. Squirrel-Tail Grass (Fox-Tail). One of the Stock Pests of Wyoming. Aven Nelson, Botanist.

" No. 20—October, 1894. The Artesian Wells of Southern Wyoming. J. D. Conley, Physicist.

FOURTH ANNUAL REPORT, 1894.

Reports from the Departments and Bulletins Nos. 17 to 20. A. A. Johnson, Director.

BULLETIN No. 21—January, 1895. I. Smuts on Grains. II. The Potato Scab. Aven Nelson, Botanist.

*Supply limited. †Out of print.

UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,
LARAMIE, WYOMING.

BULLETIN NO. 22.

APRIL, 1895.

ONIONS.

CROP REPORT, 1894.

1. Potatoes.
2. Turnips and Other Root Crops.
3. Grasses and Forage Plants.
4. Cereals.
5. Other Crops.

COST AND PROFIT OF GROWING WHEAT.

SMALL FRUITS AT LARAMIE.

BY THE AGRICULTURIST AND HORTICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

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THE HORTICULTURIST IN CHARGE,					WYOMING UNIVERSITY EXPERIMENT GROUNDS

INTRODUCTION.

BY THE DIRECTOR.

For the past four years the Wyoming Agricultural Experiment Station has sent out each year a crop report as a bulletin, in order to acquaint the farmers and ranchmen of Wyoming with the best varieties of farm and garden crops, and also the best kind of crops for Wyoming, taking into consideration the climate and altitude. We have endeavored to solve these questions in the interests of the ranchman and farmer, so that they might intelligently cultivate crops as may be successfully grown, and at the same time receive a good profit for their labor.

By the aid of our farm superintendents, who have kept accurate scientific notes, and especially by the efficiency and care of B. C. Buffum, Agriculturist and Horticulturist, and by his assistant, Mr. H. S. Kendall, we are able to present the results of 1894 on the various experiment farms. The farmers and ranchmen will be governed by the suggestions found in this bulletin, we are quite sure that it will be to their advantage.

Hereafter we shall not issue an annual crop bulletin, as we believe the past four years have enabled us to give all the information necessary, in the way of general observations and results. In the future we shall confine ourselves to special experiments; and promise our readers a bulletin on the cost and profit of growing potatoes; another on the cost and profit of growing wheat; and as experience enables us, another on fruit-growing in Wyoming. We are also giving special attention to the grasses and forage plants which may be cultivated with profit in this State, and in due time will report thereon.

A. A. JOHNSON,
Director.

ONIONS.

B. C. BUFFUM.

A variety test of Onions was commenced in 1893 and continued in 1894. The test was made upon each of the Government Farms. As far as possible each variety was given the same treatment and the test was carried on in the same manner at each of the Sub-Stations. Results sufficient for publication were not obtained at Lander or Sara-

LARAMIE.

In 1893, owing to the unfavorable season and lack of moisture, none of the varieties matured marketable winter onions. The same varieties were planted as those given in the report for 1892. In 1893 the seeds were planted May 8th and the plants were ready for market May 10th. Those which produced bunch onions, the yields were ready for market, and the yields, are as follows:

VARIETY.	Ready for Market.	Yield per Acre in Pounds.
Taker	August 28th	1,570
White Queen	" 31st	152
Red Wethersfield	Sept. 22nd	1,596
Mammoth Pompeii	" "	3,040
Portugal	" 1st	50

VARIETY.	Ready for Market.	Yield per Acre in Pounds.
Large Red Globe.....	August 15th	1,906
Giant Rocca.....	Sept. 20th	253
Yellow Globe Danvers.....	" 22nd	608
Extra Early Paris.....	" "	2,888
Spanish King.....	August 9th	1,013
Oregon Danvers, Long Keeper..	Sept. 20th	3,952
White Bermuda	August 25th	4,256
Red Bermuda.....	Sept. 20th	1,520
White Bunch.....	" 22nd	1,596
Southport White Globe.....	" 21st	608
White Victoria	" "	3,040
Red Victoria.....	August 29th	1,444
Silver White Etna.....	Sept. 22nd	608
White Multiplier Sets.....	August 2nd	1,454
Top or Button Sets.....	Sept. 22nd	902
Red Sets	" "	304

The results in 1894 are given in Table I. The season was favorable and more definite results were obtained. A part of the seed of each variety was planted in boxes indoors April 7th, and transplanted on the farm May 19th, next to those which had been sown in the open ground. Seed of each variety was sown in the open ground April 28th.

Those grown indoors were sown in ordinary shallow boxes in the Chemical Laboratory, which was then the only available place. It was impossible to give them all the same light and ventilation, and the gases of the laboratory injured all the plants to a greater or less extent. The majority of the plants were about the size of small straws when transplanted, though some of them were so small and unhealthy that they failed to grow. However, in each case

reason of the failure was apparent. All were harvested 8th and 19th.

Explanation of Table:—The name of each variety is twice in the first column, except where those trans- failed to grow, or in case of sets. In the second n the source of the seeds is indicated; P. H. & Co. ng Peter Henderson & Co., New York; L. K. Imp. ne Lee-Kinsey Implement Co., Denver; W. A. B. & V. Atlee Burpee & Co., Philadelphia.

n the third column the word "Trans." indicates that ung plants were grown indoors and transplanted; the "Seed" that the seed was sown in the open ground. columns 4 and 5 the size is given in millimeters, giv- e horizontal and vertical diameter.

n general, if the vertical diameter equals or much ex- the horizontal diameter, the onion is of poor shape, as ably has a thick neck; though this is not always the as the Red Set onion from Sheridan, No. 1, Plates 1 has a vertical diameter nearly twice its horizontal di- r, and still is of good shape.

n the next column the shape is indicated by 1 for good for poor.

he average weight is given in grams, obtained by ing three to six of the samples.

hose unaccustomed to the metric system can convert eters into inches by dividing by 25.4, the number of eters in one inch, and grams into ounces by dividing 4.

he per cent. thick-necked is large, all of many varie- ing of poor shape. This is probably largely due to ing too much or at the wrong time, and to improper

cultivation. Sufficient care was not taken to remove the soil from around the bulbs when cultivated.

TRANSPLANTING VS. SOWING SEED IN OPEN GROUND.

A glance at the table will show that the yield was generally greater from the transplanted onions, in some cases being nearly five times greater in the same variety. Again, in those varieties which produced marketable onions, with but one exception the shape was better in those which were transplanted. In a majority of cases those transplanted produced larger and better onions. The extra expense of growing the seed in hot beds or cold frames and transplanting is small compared with the increased crop and other better results.

In short, we believe in average seasons, at this altitude, (7,200 feet) the only way to grow onions from seed as a field crop, successfully, is to sow early where the young plants can be protected, and transplant into the field as soon as heavy frosts are past.

VARIETIES.

From our results very few varieties can be recommended for general culture upon the Laramie Plains. The Italian varieties were the best in shape and made the best early onions for immediate use. The New White Queen, White and Red Bermuda, Barletta, Maggiajola, Giant White Etna and Giant White Italian produce good crops of shapely onions, but, grown in our short seasons, are not good keepers.

For field crops, where they can be given proper cultivation, Large Red Wethersfield, Southport Yellow Globe, and Southport White Globe will do well and mature if started early. For very early onions we recommend sow-

the seed in the fall; cover the young plants with a layer of straw, and rake off as soon as frost is out of the ground.

Union Sets have been most successful with us. Yellow Globe and White sets for general crop, and White Mulshott and Shallots for summer use. If sets are put in the ground in the fall they are sure to mature and produce good yields.

SHERIDAN.

Fewer varieties were reported from Sheridan. The best were the El Paso, Red Bermuda, Extra Early Queen, and Extra Early Barletta. Those producing the largest yields in 1893 were Oregon Long Keeper, Yellow Globe Danvers, Red Victoria, Extra Early Flat Red, and Round Yellow Danvers. In 1894 the heaviest yields were obtained from Prizetaker, New Mammoth Pompeii, and Extra Early Selected Red Globe, Giant Rocca, and Red Wethersfield. For general field crops, the Oregon Long Keeper, Yellow Globe Danvers, Large Red Wethersfield, and Southport White Globe, both as large yielders of fine shape, and good keepers, are best.

Keeping Qualities:—The following notes, kept by Mr. J. H. Superintendent of the farm, give the keeping qualities of the different varieties. They were stored in open sheds in the root cellar.

Best Keepers. (In good condition April 1st.) Flat Red, Round Yellow Danvers, Yellow Globe Danvers, New Mammoth Silver King, Silver White Etna, Southport Globe, Oregon Long Keeper, Spanish King, Red Victoria, and all varieties of Sets except the Multi-

Second Best Keepers. (Kept till January.)

White Bermuda, Red Wethersfield, New Mammoth Pompeii.

Prizetaker kept somewhat better, showing 50 per cent. loss April 1st.

Poorest Keepers.

Early Paris, Silver Skin, White Queen, Extra Early Barletta; none of which kept for any length of time.

BEST VARIETIES.

For the northern part of the State, the following varieties are recommended: For field crops, Oregon Long Keeper, and other forms of Danvers, Red Victoria, Red Globe, with the Prizetaker and Red Wethersfield as heavy yielders and second best keepers.

SUNDANCE.

No large yields were reported either in 1893 or 1894, and the notes furnished were not sufficient to make the variety trial complete. The yields are given in the table, with the weight and size of those sent to us as samples. While none of the samples were extra large, many of them were perfect bulbs in every respect. They were thoroughly ripened, and we have never seen finer specimens of the varieties grown. The yields were much better last season than those of the previous year.

Seed onions giving best yields were Red Bermuda, Red Wethersfield, Silver King and New Queen.

WHEATLAND.

Last season the onion seed did not germinate well, and

such a complete test was made the previous season, the experiment as a variety test was abandoned.

In 1893 the instructions sent out were carefully followed and a very complete set of notes was furnished by Superintendent.

The following extract from these notes indicates the method of culture.

One fourth acre.

Fertilized with fourteen loads well rotted stable manure.

Plowed five inches deep. Harrowed five times and rolled twice.

Seed bed prepared with hand rake.

Seed planted April 6th to 8th. Sown by hand in rows ten inches apart. Covered with rake. Irrigating furrows made between the rows when seed was planted.

Soil moist beneath but top soil dry.

As soon as bulbs began to form upon each variety, the soil was carefully removed from around them. They were followed by shallow cultivation with hand hoe and hand plow.

Irrigated ten times, the temperature of the water ranging from 68 degrees F. at the first irrigation, June 14th, to 72 degrees F. at the last irrigation, August 12th.

Cultivated and hoed six times. Thinned June 26th, leaving plants from two and one-half to three inches apart in the row.

Total cost of growing one-fourth acre, \$45.00.

Other data will be found in Table II.

CONCLUSIONS.

It will be noticed that many of the varieties gave heavy crops, the White Bermuda leading with over forty-six tons, 85 per cent. of which were fit for market. These were

also the largest onions grown, the best bulbs averaging little over one pound each.

Varieties which did not mature were Oregon Long Keeper, Round Yellow Danvers, White Portugal, Spanish King, and White Bunch, either being small or thick necked. The earliest varieties to mature were Extra Early Paris, El Paso, Early White Queen, and Extra Early Barletta.

Those which can be especially recommended for field crops are Yellow Globe Danvers, White Bermuda, Large Wetherfield, and Red Globe.

COST AND PROFIT OF GROWING ONIONS.

The cost and profit of growing onions will vary with the different conditions of soil, climate, treatment and market. Onion seed loses its germinating power quickly, and if over a year old but little of it will grow. The cost of seed will vary from year to year, which alone might raise or lower the cost per acre ten or twenty dollars. However, it is believed the following summaries of cost and profit will be of value:

LARAMIE, 1894.

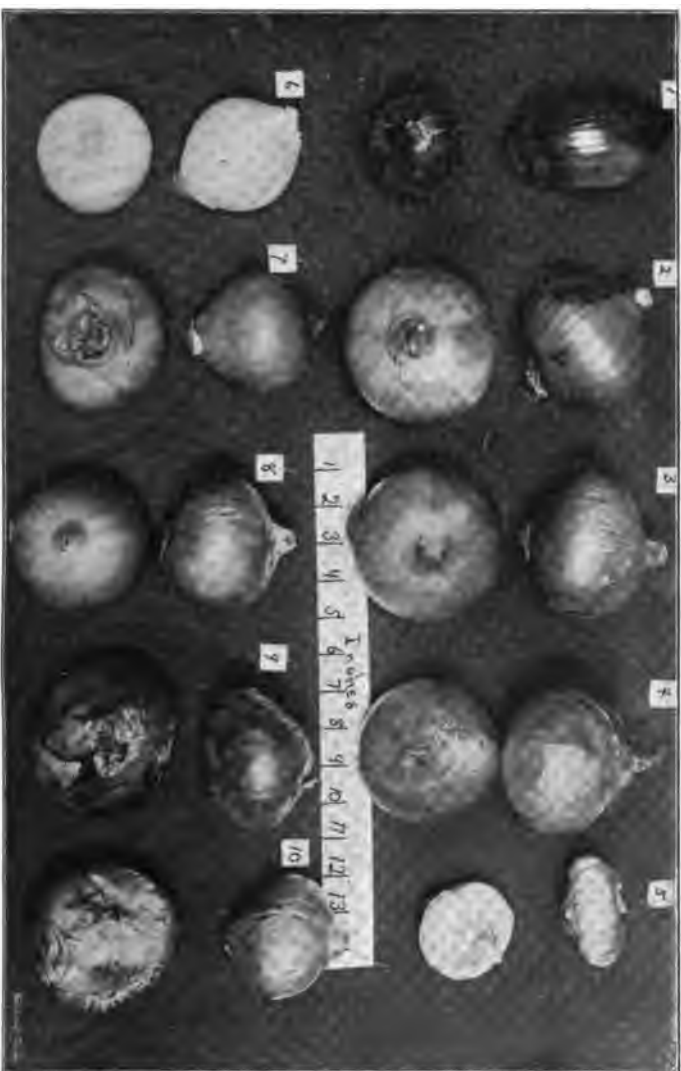
ESTIMATE FOR SET ONIONS ONLY.

Yellow Sets White Sets Red Sets	Estimated cost per acre, including	
	seed at \$3.00 per bushel.	\$ 220 00
	Average yield	31,355lbs
	Average fit for market, 99 per ct.	
	Yield of marketable bulbs	31,041lbs
	*Value at 3 cts. per pound.	\$ 931 23
	Profit (local market)	\$ 711 23
	Value at 1 ct. per pound	\$ 310 41
	Profit per acre (general market)..	\$ 90 41

*The estimate based upon local market is at the price we received for those sold. Large amounts could not be sold at such prices. At wholesale, 1 ct. per lb. would probably be the best price realized.



PLATE I.



WHEATLAND, 1893.

TEN BEST VARIETIES.

Yellow Globe Danvers	Cost per acre, including seed at \$4.00 per lb. . . . \$ 200 00 Average yield 49,994 lbs Average fit for market 80.5 per cent. Average yield of marketable bulbs . . 40,245 lbs Value at 1 ct. per lb. . . . \$ 402 45 Profit per acre \$ 202 45
Early Paris	
Red Bermuda	
Early Flat Red	
Wethersfield	
White Queen	
Mammoth Pompeii	
Red Bermuda	
Queen	
Red Globe	

EXPLANATION OF PLATES I AND II.

Two onions of each variety are shown. The upper gives a side view and the lower one a view of the top bulb. This gives the horizontal and vertical diam-

The same onions are shown in longitudinal and cross section in Plate II. Numbers 1, 3, 4 and 9 were grown at Wheatland, numbers 2, 6, 7 and 8 at Wheatland, and numbers 5 and 10 at Sundance.

The name of 7 should read Yellow Globe Danvers. The scale of inches shows the size of the bulbs.

Plate II shows the character of the varieties, a glance being given to the onions which are most perfect and solid.

Numbers 4 and 7 are the same varieties, and number 8 is the same under a little different name. Number 3, the Yellow Globe Danvers Long Keeper, is much the same, though the number of complete rings is greater. All have two or three incipient shoots or germinating centers. It will be noted that in number 9, these divisions are not so well marked with outside rings. The dark places in the cut

show that these bulbs were beginning to spoil when the picture was taken, and the lack of continuous smooth outside covering of layers may be an explanation of the Red Wethersfield not keeping well. If the onions otherwise grow and ripen well, we believe this point an important one in determining the keeping quality. Number 5 in the cut was also beginning to spoil because it was full of sap, and not well ripened.



PLATE II.



NAME OF VARIETY.	Seed from.	How planted.	Horizontal Diam. Mm.		Vertical Diam. Mm.	Shape.	Aver. Wt. Be Bulbs in Gr.	Yield per Ac in Poun	Per cent. fit for Mark	Per cent. Sm	Thick-neck	Remarks.
			Horizontal Diam. Mm.	Vertical Diam. Mm.								
1 Prizetaker	P. H. & Co.	Trans.	66	92	2	148	12,788				100	Did not mature.
"	"	Seed.	66	95	2	96	11,954				100	" "
2 New White Queen	L. K. Imp. Co.	Trans.	71	44	1	105	8,131.5	90	10			" "
"	"	Seed.	70	37	1	69	8,340	86	11		3	" "
3 Extra Early Flat Red	"	"	56	54	2	76	14,456				100	" "
4 Burpee's Mammoth Silver Skin	"	"	72	45	1	81	10,842				25	" "
5 Extra Early Selected Red Globe	"	Trans.	47	65	2	45						" "
"	"	Seed.	68	105	2	158	14,178				100	" "
6 Large Red Wethersfield	"	"	80	67	1	133	15,012	8			92	" "
7 New Mammoth Pompeii	"	"	66	60	2	97	16,124				100	" "
8 White Portugal or Silverskin	"	Trans.	58	44	1	56						Matured.
"	"	Seed.	76	57	1	78	11,120	76			24	1/2 matured.
9 Giant Rocca	"	Trans.	72	111	2	147	14,456				100	Did not mature.
"	"	Seed	73	56	2	112	15,012				100	" "
10 Yellow Globe Danvers	"	Trans.	60	90	2	81	7,228				100	" "
"	"	Seed	60	64	2	90	13,344				100	" "
11 Extra Early Paris	"	Trans.	72	64	1	103	17,859	35	5		60	" "
"	"	Seed.	64	42	2	62	11,120	6	31		63	A few matured.
12 Oregon Danvers Long Keeper	"	Trans.	69	74	2	138	16,324				100	Did not mature.
"	"	Seed.	54	59	2	71	9,730				100	" "
13 Southport Yellow Globe	P. H. & Co.	Trans.	55	100	2	106	12,649				100	" "
"	"	Seed.	42	55	2	63	10,286				100	" "
14 White Bermuda	"	Trans.	77	47	1	112	10,605	100				Matured.
"	"	Seed.	54	38	1	46	3,892	82	15		3	" "

TABLE I—Continued. LARAMIE, 1894.

NAME OF VARIETY.	Seed from.	How planted.	Size.		Shape	Aver. Wt. Best Bulbs in Grams.	Yield per Acre in Pounds.	Per cent. fit for Market.	Per cent. Small.	Per cent. Thick-necked.	Remarks.
			Horizontal Diam. Mm.	Vertical Diam. Mm.							
15 Yellow Dutch	P. H. & Co.	Trans.	91	66	2	215	18,702	2	50	100	Did not mature.
" "	"	Seed.	49	50	2	64	9,452	48	21	48	" " "
16 Red Bermuda	"	Trans.	68	48	1	66	8,625	75	21	4	Matured.
" "	"	Seed.	63	48	1	80	5,838	100			"
17 Round Yellow Danvers	"	Trans.	60	92	2	124	18,612				Did not mature.
" "	"	Seed.	55	90	2	83	10,008				" " "
18 White Bunch	"	Trans.	70	80	2	136	32,915				" " "
" "	"	Seed.	69	71	2	89	6,672				" " "
19 Southport White Globe	"	Trans.	65	110	2	144	20,473				" " "
" "	"	Seed.	45	95	2	56	8,340				" " "
20 White Victoria	W. A. B. & Co.	Trans.	93	73	1	251	35,651	13	11	76	" " "
" "	"	Seed.	83	58	2	151	10,008	9	38	53	" " "
21 New Pink Prizetaker	"	Trans.	62	67	2	152	22,796				" " "
" "	"	Seed.	54	60	2	89	9,452				" " "
22 Red Victoria	"	Trans.	85	62	2	223	38,364	12		88	" " "
" "	"	Seed.	63	62	2	84	8,896			100	" " "
23 New Adriatic Extra Early Barletta	"	Trans.	81	46	1	112		100			Matured.
" "	"	Seed.	73	53	1	126	8,896	86		14	" " "
24 Neapolitan Magginiola	"	Trans.	50	39	1	27					"
" "	"	Seed.	64	41	1	52	6,394	100			"
25 New Mammoth Silver King	"	Trans.	74	65	1	135	2,377				Did not mature.
" "	"	Seed.	61	44	1	69	8,896	15		85	" " "
26 Silver White Etna	"	Trans.	76	55	1	167					" " "
" "	"	Seed.	75	39	1	61	9,452	93	31	4	A few matured

NAME OF VARIETY.	Seed from.	How planted.	Horizontal Diam. Mm.	Vertical Diam. Mm.	Shape.	Aver. Wt. Bes. Bulbs in Grm.	Yield per Acre in Pound	Per cent. fit for Marke	Per cent. Small	Per cent. Thick necked	Remarks.
27 Giant Yellow Rocca	"	Trans.	65	82	2	124					Did not mature.
"	"	Seed.	58	50	2	60	9,452	4		96	" " "
28 Giant White Italian	"	Trans.	81	52	1	120					" " "
"	"	Seed.	76	41	1	79	8,340	98		2	Matured.
29 Yellow Sets	P. H. & Co.	Sets.	92	56	1	232	38,920	99		1	"
30 White Multiplier Sets	"	"	55	40	1	51	10,842	50	50		"
31 Top or Button Sets	"	"	60	72	2	120	20,572			100	Did not mature.
32 Red Sets	"	"	106	48	1	232	21,506	100			Matured.
33 White Sets	"	"	93	76	1	204	33,638	98	1	1	"
34 Shallots	"	"	68	61	1	187	48,094	100			"

Table II. ONIONS.

1893

VARIETY.	SHERIDAN.					SUNDANCE.				
	Matured.	Yield per Acre	in Pounds, Average Weight of Best Bulbs in Grams.	Size.		Matured.	Yield per Acre	in Pounds, Average Weight of Best Bulbs in Grams.		
				Horizontal Diam. Mm.	Vertical Diam. Mm.					
Oregon Danvers.....	Oct. 1	14,850	205	91	70	Sept. 20	548	56		
Yellow Globe Danvers.....	" 1	14,256	272	98	75	" 21	1,096	113		
Extra Early Paris.....	" 1	10,395	146	75	65	" 20	685	75		
Silver White Etna.....	" 1	5,940				" 21	822	94		
White Bermuda.....	" 1	6,237	266	110	77	" 19	1,096	75		
Red Victoria.....	" 1	17,226	152	86	62	" 21	2,466	151		
Extra Early Flat Red.....	" 1	14,850	132	80	50	" 21	3,217	189		
Large Red Wethersfield.....	" 1	13,662	202	90	65	" 21	595	265		
Spanish King.....	" 1	7,722	72	62	50	" 21	3,175	189		
El Paso.....	July 15	3,663				" 21	959	113		
Red Bermuda.....	" 15	2,009		37	31					
White Portugal.....	Oct. 1	11,286	142	77	55	" 21	2,111	227		
Round Yellow Danvers.....	" 1	14,256	143	77	55	" 19	685	75		
Early White Queen.....	July 15	2,376				" 21	685	75		
Extra Early Barletta.....	" 15	3,267		52	35	" 21	822	94		
Prizetaker.....	Oct. 15	3,861	46	50	77	" 21	1,061	227		
New Mammoth Pompeii.....			135	77	72	" 20	1,233	151		
Southport White Globe.....			174	75	80	" 19	274	37		
White Multiplier.....				45	40	" 19	2,278	227		
New Mammoth Silver King.....						" 21	822	94		
Giant Rocca.....						" 21	1,370	132		
Pale Red Bermuda.....						" 20	411	56		
White Bunch.....						" 19	411	37		
White Victor.....										
Red Victor.....										
New Queen.....						" 20	685	75		
Early Red Globe.....						" 21	2,111	189		
Long Red Globe.....						" 20	685	75		

WHEATLAND.								Weight of twelve Largest Bulbs in Pounds & Ounces.
Matured.	Yield per Acre in Pounds.	Average Weight of Best Bulbs in Grams.	Size.		Per cent. fit for Market.	Per cent. Small.	Per cent. Thick-necked.	
			Horizontal Diameter in Millimeters.	Vertical Diameter in Millimeters.				
Matured.	10,494	118	72	57	20	10	70	3 pounds
ber 16	26,712	150	75	61	80	20		6 "
1	68,734	118	63	44	80	20		7 " 2 oz.
8	32,436	109	62	44	75	25		6 "
16	93,492	208	74	43	90	10		12 " 3 "
		104	49	53				
10	32,436	181	77	48	90	10		7 " 7 "
10	40,545	141	78	53	75	25		9 " 8 "
Matured.	11,925				10	75	15	3 " 4 "
ber 5	25,281	124	69	47	70	30		5 " "
Matured.	10,017					10	90	
"	7,632				20	60	20	2 " "
ber 5	35,775	123	63	43	80	20		7 " 4 "
1	30,528	107	62	40	75	25		5 " 2 "
12	20,988	190	76	62	60	40		6 " 7 "
12	61,056	62	62	40	75	25		7 " 5 "
18	6,201				80	20		4 " "
8	20,988	103	41	31	80	20		6 " "
20	12,879	137	55	55	20	5	75	4 " "
16	41,022	129	66	48	80	20		9 " "
Matured.	11,448				60	20	20	5 " "
ber 8	23,850	96	60	51	50	30	20	4 " 3 "
10	20,511				80	20		6 " 7 "
10	59,625	102	55	38	75	25		6 " 2 "
12	40,545	168	70	55	80	20		8 " 1 "
16	17,172				60	20	20	6 " "

Table III. ONIONS.

1894

VARIETY.	SHERIDAN.					SUNDANCE.				
	Matured.	Yield per Acre in Pounds.	Average Weight of Best Bulbs in Grams.	Size.		Yield per Acre in Pounds.	Average Weight of Best Bulbs in Grams.	Size.		
				Horizontal Diam. Mm.	Vertical Diam. in Mm.			Horizontal Diam. Mm.	Vertical Diam. in Mm.	
New Queen.....	July 29	3 768.9				8,160	77	61	51	
Silver White Etna.....	" 29	6.998				7,480	100	75	45	
Extra Early Selected										
Red Globe.....	Sept. 1	19,424.6	262	92	65	1,768				
Yellow Dutch.....	" 1	14,496	163	78	63	6,130				
White Bermuda.....	" 1	4 348.8				7,208	62	63	35	
Giant White Italian.....	" 1	5,291				7,344	88	83	31	
Extra Early Paris.....	July 29	5 436				7,888				
Burpee's Mammoth										
Silver King.....	Sept. 1	8,335.2				9,520	69	69	26	
Exton's Silver Wh. Portugal	" 1	13,843				5,400				
White Bunch.....	" 1	12,901				6,664	62	63	50	
New Mammoth Silver King	" 1	12 321.6				8,568	102	79	52	
Red Bermuda.....	" 1	14,496	286	95	72	10,336	131	76	59	
Yellow Globe Danvers.....	" 6	11 959.2	357	103	80	4,216	115	79	53	
Prizetaker.....	" 6	20,294.4	341	91	97	6,800				
Oregon Danvers L'g Keeper	" 6	11,886.7	353	97	67	3,808	63	64	49	
Extra Early Red.....	July 29	4,348.8	216	88	54	5,032	102	69	44	
Red Wethersfield.....	Sept. 5	18,120	276	99	63	9,928	128	85	55	
Giant Rocca.....	" 5	18,844.8				6,936	93	73	45	
New Mammoth Pompeii.....	" 5	19,928				4,080	69	69	38	
Southport Globe.....	" 5	10,872								
Prizetaker Globe.....	" 5	20,294.4								
Southport Yellow Globe.....			201	82	67	4,352				
Southport White Globe.....						2,580				
New Extra Early Adriatic.....						6,120	78	71	41	
Neapolitan Maggiajola.....						2,692	90	75	36	
Red Victoria.....						6,320	64	67	42	
Round Yellow Danvers.....						4,312	80	66	46	
Giant Yellow Rocca.....			287	96	61	2,488	122	85	48	
Prizetaker (Dep't seed).....						6,488	188	87	71	
Shallots.....						32 640	93	59	45	
White Multiplier.....						4,896	32	60	43	

CROP REPORT, 1894.

POTATOES. (PROGRESS REPORT.)

A general test of varieties, to be carried on for three consecutive seasons upon each of the Experiment Farms, begun last year. All the leading varieties will be

At the same time, various experiments with potatoes of different methods of culture and treatment will also receive attention. As this was the first season of the test, we make no comment upon the varieties given in Tables IV and V, and report the special experiments as follows:

WHOLE VS. CUT SEED.

In Table V are given the comparative yields from whole and cut seed at Wheatland. The notes furnished us state the exact method of cutting the seed. Directions were given to cut the potatoes, leaving two eyes in each piece. The larger yield obtained from whole seed is evident. The average yield from nineteen varieties with which the test was made, was 103.8 bushels from cut seed and 177.2 bushels from whole seed, an increase of ninety per cent. in favor of planting whole potatoes.

No notes were furnished from Sundance upon the test but the Superintendent reports that a "Comparative test with whole and cut seed shows the cut seed to be much preferable."

METHODS OF CUTTING SEED POTATOES.

At Lander the following test was made to determine which of the eight methods of preparing the seed would produce the largest amount of marketable potatoes. The variety used was Pride of the West. The total yield given is the number of pounds produced from twenty pounds of seed in each case.

POTATOES.

TREATMENT	TOTAL YIELD LBS.	Large, lbs.	Small, lbs.
No. 1—Cut in quarters lengthwise of tubers, leaving seed ends on	335	308	27
No. 2—Cut same as No. 1. Treated with corrosive sublimate. There was no scab on potatoes from treated or untreated seed, and the treatment seemed detrimental	305	285	20
No. 3—Small potatoes left whole...	310	278	32
No. 4—Cut one eye to a piece. Seed end cut off	244	222	22
No. 5—Cut as nearly as possible one eye to a piece and seed end left on	210	190	20

POTATOES—Continued.

TREATMENT	TOTAL YIELD LBS	Large, lbs.	Small, lbs.
Cut in halves lengthwise of tuber. Largest tubers not used	174	151	23
Cut in halves lengthwise of tuber. Seed ends cut off. Largest tubers not used . . .	102	84	18
Cut in halves lengthwise and each half cut in two cross- wise, leaving seed ends on	321	289	32

the above experiment it will be noticed that No. 1, the tubers in quarters lengthwise, leaving a part of seed end on each quarter, gave the best result.

No. 8, in which the seed was also quartered, gave the best result.

Cutting one eye to each piece, first having cut off the seed end, gave a better result than when the seed end was left on, which would necessitate cutting much smaller pieces.

When cut in larger pieces, a comparison of numbers 1 and 7 indicates that it is better to leave seed end on.

TREATED VS. UNTREATED SEED.

Table V, the yields at Lander from treated and untreated seed are given. Twelve varieties were used in this experiment, each being divided into two equal parts. One part was treated by dipping into a solution of corrosive sublimate for the scab. Nearly all the seed showed some scab when planted, but when harvested there was practically no

scab upon the potatoes from either treated or untreated seed. Those that were treated were longer coming up, and did not seem to do as well at any time during the season as the plants from untreated seed.

The average yields from the twelve varieties were from treated seed 118 bushels, and from untreated seed 171 bushels.

NOTE.—It must not be inferred from the above test that treating seed for potato scab should not be resorted to. No data were supplied regarding the strength of the solution used, length of time the seed was left in the solution, whether treated before or after being cut, or other facts concerning it, without which no definite conclusions can be drawn. The point clearly demonstrated is that this treatment may be injurious. Whether it is injurious when properly done with a solution just strong enough to kill the scab, is not proved by these data.

COST AND PROFIT OF GROWING POTATOES.

LARAMIE.

Estimated cost of growing crop per acre, including labor, fertilizer and seed. . . . \$ 50 0

Maximum Profit—

Yield of marketable tubers, "Chas. Downing," 521.5 bushels

Value at 1 ct. per pound \$ 312 9

Profit \$ 262 9

Average of 51 Varieties—

Estimated cost per acre. \$ 50 0

Average yield. 224 bu.

Average per cent. fit for market. . . . 85.3

Average yield marketable potatoes 191 bu.

Value at 1 ct. per pound \$ 114 6

Profit per acre. \$ 64 6

The small yields of a few varieties lower the average. If these eliminated, the profit would be greater. Our rate of cost of producing the crop is high, as it includes cost of fertilizer and labor, under the unfavorable conditions in which our farm is placed.

LANDER.

Estimated cost per acre, including seed.....	\$32.50
Average yield of 12 varieties from treated and untreated seed.....	144.8 bu.
Value of crop at 1 cent per pound.....	86.88
Profit per acre.....	\$54.38

The potatoes were all badly injured by the Salt Lake locust, making the yields smaller than usual.

WHEATLAND.

Estimated cost per acre	\$30.50
Average yield from 19 varieties, from whole and cut seed	150.5 bu.
Value at 1 cent per pound.....	90.30
Profit per acre.....	\$59.80

TABLE IV.

POTATOES.

1894

LARAMIE.

NAME.	In Bloom.	Total Yield per Acre in Bu.-bels.	Per cent. Marketable	Weight of 6 Largest.	Condition at Time of Frost.
1 Freeman		207	78	2 lbs. 4 oz.	Tops green.
2 Empire State		257	88	2	" "
3 Brownlee's Winner		209	84	2	" "
4 Rose Seedling		242	95	3	" ripening.
5 Polaris		142	77	1	" dead.
6 White Elephant	July 17	280	3	5	" ripening.
7 Burpee's Extra Early	" 17	161	90	2	" ripe.
8 Boston Red		330	87	2	" ripening.
9 Rural New Yorker		173	91	3	" "
10 Albino		82	88	2	" "
11 Blue Victor	July 17	342	96	6	" ripe.
12 Burpee's Superior	" 17	369	95	3	" ripening.
13 New Queen		49	38	1	" green.
14 Monroe's Seedling	July 17	369	96	3	" ripening.
15 Early Six Weeks		134	91	1	" green.
16 Ohio Junior		211	93	2	" ripe.
17 Early Market		130	91	2	" "
18 Early Ohio		47	61	1	" "
19 Montana Wonder		300	96	5	" green
20 St. Patrick	July 10	211	91	3	" "
21 Rural Blush	" 17	284	91	3	" "
22 Chicago Market	" 10	211	80	4	" "
23 Delaware		323	95	4	" "
24 Summit	July 17	122	48	2	" "
25 Early Minnesota	" 17	288	89	2	" "
26 Reed's No. 86		119	84	1	" ripe.
27 Chas. Downing	July 17	549	95	2	" "
28 Pride of the West		227	95	2	" green.
29 Morning Star	July 17	244	91	2	" "
30 Arizona	" 17	267	91	3	" "
31 Red Ohio		53	50	2	" ripe.
32 Early Northern	July 10	368	95	3	" green.
33 White Star	" 10	184	91	3	" "
34 Early Sunrise	" 17	242	83	2	" "
35 Rochester Rose	" 17	298	90	2	" "
36 Clark's No. 1	" 17	201	84	1	" "

Table IV—Concluded. POTATOES.

1894

LARAMIE.

NAME.	In Bloom.	Total Yield per Acre in Bushels.	Per cent. Marketable.	Weight of 6 Largest.	Condition at Time of Frost.
Thornburn	July 17	242	87 2	lbs. 3 oz.	Tops ripe.
ate Puritan	" 17	294	93 4	6	" green.
anguard	" 17	180	82 1	8	" ripe.
earl of Savoy	" 10	269	87 2	10	" green.
Manitoba Rose	" 17	300	88 2	12	" "
oshkonong		292	94 3	11	" "
ill Nye	July 10	269	90 3	2	" "
ow Drop	" 17	230	89 2	15	" "
acme Seedling	" 17	99	61 3	0	" ripe.
akota Red		59	51 2	0	" green.
alexander Prolific	July 10	252	92 4	6	" "
World's Fair		219	95 3	0	" "
arly Rose	July 17	228	91 3	8	" "
arly Rose Seedling		124	96 4	4	" "
mammoth Pearl		141	93 4	2	" "

TABLE V.

POTATOES.

1894

Number.	NAME.	WHEATLAND.			LANDER.		
		Yield per Acre in Bushels.		Weight of 12 Largest.	Yield per Acre in Bushels.		Weight of 12 Largest.
		Seed Cut.	Seed Whole.		Seed Treated.	Seed Untreated.	
1	Early Rose.....	126.0	222.0	6 lbs. 4 oz.	126.2	129.0	7 lbs. 8 oz.
2	Early Mayflower.....	177.0	215.0	10 4	200.5	281.3	7 8
3	Early Puritán.....	145.0	217.0	16 0	102.0	143.0	7 8
4	White Elephant.....	124.0	443.0	25 8	176.7	220.2	11 0
5	Snow Drop.....	83.0	162.0	18 10	57.7	139.0	7 8
6	Empire State.....	89.0	171.0	16 9	111.7	199.4	8 0
7	Bill Nye.....	85.0	194.0	23 8	168.9	187.2	7 8
8	Late Puritan.....	108.5	167.8	18 2	91.7	152.3	8 0
9	Beauty of Hebron.....	122.2	137.5	12 0	103.4	223.3	8 8
10	Triumph.....	69.0	171.0	23 8	89.3	152.2	8 8
11	Jumbo.....	91.8	204.5	29 8	122.0	187.0	10 0
12	Vanguard.....	105.1	206.5	22 14	65.7	46.0	7 8
13	Early Ohio.....	43.0	177.0	8 2			
14	Hoffman.....	101.0	182.0	19 7			
15	Rose Seedling.....	81.0	148.0	29 0			
16	Gov. Rusk.....	123.0	207.0	26 2			
17	Pride of the West.....	81.0	135.5	17 7			
18	Mammoth Pearl.....	126.7	253.3	29 13			
19	New Burbank.....	91.2	133.0	20 3			

TURNIPS.

The conditions of soil and climate upon the Laramie Plains are eminently favorable to the growth of turnips. At lower altitudes where the seasons are long and warm, turnips cannot be sown in the spring for a fall crop, as they become strong and unfit for either table use or stock. There is no difficulty of this kind here, for though the roots grow to a large size, they never become strong. Tur-



PLATE III.



are highly prized in England as a stock feed, to be fed with hay or grain for fattening beef. Here, where there is no other feed of a succulent nature, turnips for stock would be valuable, and well repay the expense of growing for that purpose. No other crop that we have tried will give so many pounds of feed per acre. The average yield of the varieties given in Table VI, sown with drill, was 33.8 pounds, or 30.3 tons per acre. The expense of growing them is small. A safe estimate with the yields we obtained would make the expense of producing the turnips, inclusive of harvesting and hauling, at 50 cents per ton, or less. This would be cheaper than hay, and much cheaper than any other stock feed which can be obtained here. Although the nutritive value of turnips is low, they will be a valuable feed in connection with hay or grain.

Autabagas or Swede turnips can be grown with the same success, and are more valuable as feed than the white varieties.

The Early White Egg is the finest early turnip for table use. They grew very large, the two largest ones being shown in Plate III, weighing 14 lbs. 2 oz. each. They were sown May 18th and harvested October 20th, at which time the flesh of the largest was firm and sweet throughout. This variety also gave the largest yield, producing at the rate of 41.4 tons per acre. Some of the roots were pulled in the summer for market. Not counting these, the total at the final harvest was 39.9 tons.

Robertson's Golden Ball is a smooth yellow turnip, suitable for fall and winter table use. A specimen weighing 14 lbs. is shown in Plate III. The weight of the three roots shown in the plate aggregate 40¼ lbs.

SOWING BROADCAST VS. WITH DRILL.

Our experiment with turnips was to determine the comparative results of sowing broadcast and with drill. One row 200 feet long was sown in each manner. The rows were thirty inches apart, and in the one sown broadcast, the seed was sown upon a strip about one foot wide and raked in with a hand rake, May 8th. The soil was comparatively moist, and there was practically no difference in the date the plants came up, but those sown with drill had the best stand in each case. The largest turnips were produced in the row sown broadcast, as the seed failing to grow gave them more room. A glance at Table VI shows the larger yields from those sown with drill in each case. The averages for the twelve varieties sown in each way are: drilled, 60,578.8 lbs. sown broadcast, 28,429 lbs.

TABLE VI.

TURNIPS.

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LARAMIE EXPERIMENT FARM.

Number	VARIETY.	Yield per Acre.		Weight of 60 acres
		Planted with Drill.	Sown Broadcast	
		Pounds.	Pounds.	lbs.
1	Early White Flat Dutch.....	53,280	38,054	183
2	Golden Ball	40,951	15,683	171
3	Purple Top Strap Leaf	41,975	22,131	163
4	Extra Early Snowball	63,430	49,838	386
5	Yellow Stone.....	41,299	9,497	241
6	Robertson's Golden Ball.....	68,223	30,147	224
7	White Stone.....	80,160	20,475	201
8	Pomerian White Globe.....	64,650	32,862	343
9	Early White Top Strap Leaf.....	47,616	16,772	23
10	Large White Norfolk	74,343	32,782	36
11	Early Red Top Globe.....	68,244	22,893	341
12	Early White Egg	82,775	50,014	72

PARSNIPS.

All the parsnips raised were of excellent quality. The Round Early and Early Short Round or Stump Rooted, appeared to be the same variety. The roots were all of good marketable size. They are much easier to harvest than the long varieties, and we consider them

VARIETIES	Yield in Pounds per Acre	Per Cent. fit for Market
Round Early.....	3,147	100
Seely or Hollow Crown	8,234	53
Smooth or Sugar.....	7,337	57
Short Round Stump Rooted	2,387	100

CARROTS.

Planted May 10th with drill and harvested from August to October 22nd. The Yellow Belgian and White Belgian were long, of good size and good yielders. They are good stock carrots.

Our favorite early varieties with us, in their order of excellence, are Early Half Long Scarlet Corentan, Early Long Scarlet Nantes, Early Half Long Stump Rooted and French Forcing.

VARIETIES	Yields in Pounds per Acre	Weight of Twelve Largest Roots
Half Long Scarlet Nantes....	15,328	7 lbs. 2 oz.
Half Long Scarlet Corentan ..	15,400	8 lbs. 5 oz.
Scarlet Horn.....	11,327	6 lbs. 8 oz.
Half Long Stump Rooted	21,107	8 lbs.
Yellow Belgian	17,807	9 lbs. 12 oz.
White Belgian	15,814	10 lbs.
Early French Forcing.....	13,987	5 lbs.

BEETS.

Planted with drill May 11th. None of the varieties produced either large beets or large yields. The earliest varieties for table use were Dewing's Early Blood Turnip and Flat Dark Egyptian. The following table gives the yields of each variety, with the weight of twelve largest roots.

VARIETIES	Yield in Pounds per Acre	Wight of Twelve Largest Roots
Dewing's Early Blood Turnip.....	17,382	25 lbs.
Early Blood Turnip	17,353	21 lbs.
Extra Early Flat Bassano.....	12,982	24 lbs.
Extra Early Flat Dark Egyptian...	27,515	14 lbs.
Long Smooth Blood Red.....	15,342	19 lbs.
Eclipse	19,815	16 lbs.
Egyptian	14,057	10 lbs. 8 oz.
Henderson's Half Long	10,630	8 lbs.
Electric	10,446	
Columbia	9,395	
Dirigo Blood Turnip.....	9,219	7 lbs.

SUGAR BEETS. LARAMIE, 1894.

	VARIETY				
	Klein Wanzleben	Vilmorin Improved	White Si-lesian	New Danish	Mettee
Weight, grams ..	264	203	400	474	300
“ ounces ..	9	7	14	16	11
Specific Gravity.	1.085	1.088	1.081	1.074	1.0845
Solids	20.4	21.1	19.5	17.9	20.3
Sugar in Juice. ..	16.37	17.83	15.83	13.40	16.66
“ in Beets. ...	15.66	16.94	15.04	12.83	15.83
Purity	80.4	84.4	81.0	75.4	81.7
Yield per Acre, in pounds	15822.5	25,329	17,258	56,784	28,122

SUGAR BEETS. SHERIDAN, 1894.

	VARIETY			
	Vilmorin Im- proved	Klein Wanz- leben	White Si- lesian	Mettec
Weight, grams.....	220	310	307	387
" ounces.....	8	11	11	14
Specific Gravity.....	1.115	1.108	1.0975	1.102
Moisture.....	26.9	25.4	23.1	24.1
Sugar in Juice.....	22.73	21.83	20.00	21.66
" in Beet.....	21.60	20.74	19.00	20.58
Specific Gravity.....	80.3	85.8	88.6	89.6
Yield per Acre, in pounds	22,215	19,502	16,978	31,363

JERUSALEM ARTICHOKE.

Planted in 1891. The last two seasons they have had no special care and have not been irrigated. However, they have survived through the winters and the ground is full of tubers in the spring (1895). They are recommended for hogs at all altitudes. At lower altitudes they are difficult to eradicate when once introduced.

SALSIFY.

The Vegetable Oyster was planted May 10th. The tubers were left in the ground all winter and harvested April 10, 1895. Common White Rooted Salsify yielded at the rate of 10,342 lbs. per acre, of which 70.6 per cent. was fit for market. Sandwich Island yielded 13,794 lbs. per acre, of which 89.5 per cent. fit for market. The quality of both varieties was good. The Sandwich Island produced roots

much larger than the common variety, but did not keep so well in the ground as when harvested. The common was perfectly sound while many of the roots of the Sandwich Island had commenced to rot.

ALFALFA.

One half acre sown April 27th. Seed at the rate of 40 lbs. per acre was used and a fine stand secured. It was mowed August 17th and yielded at the rate of 1967 pounds per acre, which is good for the first cutting after seeding. The young plants came through the winter in good shape. Alfalfa has long been successful at altitudes below 6000 feet in this State, but many upon the Laramie Plains have believed it could not be successfully grown here. So far no other plant has been found which equals it in the amount of nutritious hay produced per acre, and it is recommended as the best hay crop for this section of the state, as well as for others. However, to be successful with Alfalfa at this altitude, it requires careful treatment. Care must be taken not to irrigate too much, or more often than is absolutely necessary to keep it from dying out. The nights are always cool, and if the soil is kept cold and damp with too much water the alfalfa plants make small and slow growth. Heavy seeding (from 30 to 40 pounds per acre) is recommended. Failure often results from sowing the seed broadcast and harrowing it in upon ground which dries out so soon that the seed does not germinate. If the ground is dry, irrigate before planting rather than afterwards. Never sow alfalfa seed upon the sod. The ground should be

plowed and pulverized. Putting the seed in properly is most important to insure success, and the "Press Drill" is the best machine for sowing any kind of seed usually sown broadcast in our dry climate. Planting in the spring (the first of April or during May) gives the plants a chance to become well rooted, so they are not apt to dry out and winter-kill.

At Wheatland, one acre of alfalfa which was sown in June, 1891, was cut three times in 1894 and produced at the first cutting, June 23, 4 tons of hay; at the second cutting, August 6, 3.5 tons; at the third cutting, September 2, 2.16 tons, or a total for the season of 9.66 tons of hay.

MILLET.

Common Millet, sown May 14th, grew slowly until the latter part of the summer. It yielded 731.6 pounds of seed per acre, and the hay crop gave 6,030 pounds, or over 6 tons per acre, of cured hay. The hay was cut August 27th. In raising millet at this altitude care must be taken not to irrigate more than is absolutely necessary to keep the crop from drying out.

Hungarian Millet was planted on ground which was wet by seepage, and made uneven growth. It was cut May September 10th and yielded 2,128 pounds of cured

RAPE.

One half acre of Dwarf Essex Rape was sown May 1st. This crop is raised for feed for stock or for ensilage.

It made a rank growth and yielded 14.6 tons of green fodder per acre.

KAFFIR CORN.

Wheatland. Planted May 12. Harvested September 25. Yielded 4,800 pounds of fodder. / This variety failed to mature seed. Quality of fodder fair.

JERUSALEM CORN.

Wheatland. Planted May 12. Harvested September 25. Yield, 1,600 pounds of fodder. It failed to mature for seed. Yield was small but quality of fodder good.

MILO MAIZE.

Wheatland. Planted May 12. Harvested September 15. Yield, 20,000 pounds of fodder. It matured seed in 123 days. Superintendent states that quality of fodder could not be excelled.

BROWN DHOURA.

Wheatland. Planted May 14. Harvested September 15. Yield, 19,200 pounds of fodder. Matured seed in 123 days. Recommended as a profitable forage plant.

TIMOTHY.

Wheatland. Planted in April, 1892. Harvested, Ar-

6, 1894. Yield, 1.7 tons per acre. Quality of hay,

AWNLESS BROME GRASS.

Wheatland. Planted, May 10, 1892. Harvested, July
Yield, 2.2 tons per acre. Height of grass when cut,
feet. The stalks well covered with leaves. Quality of
first-class.

CEREALS.

The following notes give the results with cereals at
of the Experiment Farms. Where the name of the
is not mentioned, the home station at Laramie is re-
ferred to. Upon the Laramie Farm all the varieties ripened
and produced heavy, plump grain. As no apparatus
at hand to determine the weights per bushel of the dif-
ferent varieties, these important data are necessarily omit-
ted. The yields given in bushels were computed using 60
pounds per bushel for wheat, 32 pounds for oats, 48 pounds
for barley, 60 pounds for Hulless barley, 72 pounds for

At Laramie, Lander and Wheatland, yields with
different methods of fertilizing are given under the variety
under which the test was made. Where only small areas
were planted upon the Laramie Farm, the amount of land
used is given in each case. Where planted in rows they
were fifteen inches apart and the grains were cultivated the
same as garden crops. All other planting was done with

the "Press Drill." Computing yields from such small areas, with the method of treatment, accounts for the large yields.

WHEAT.

AUSTRALIAN CLUB.—Three rows, each 100 feet long, were planted April 27th. Ripe August 28th. Yield per acre, of grain and straw, 8,973 pounds. Yield of grain, 63.9 bushels,

NIAGARA.—One row, 100 feet long, planted April 27th. Ripe September 3rd. Yield per acre, of straw and grain, 11,021 pounds; grain, 78.7 bushels.

NIAGARA.—At Sundance.—Ripe August 7th. Yield, 22 bushels.

IMPROVED FIFE.—Three rows 98 feet long. Planted April 27th. Ripe September 6th. Yield per acre, of straw and grain, 8,890 pounds. Yield of grain, 53.3 bushels.

POLISH.—Four rows 98 feet long. Planted May 1st. Ripe September 6th. Yield per acre, of straw and grain, 7,349 pounds; grain, 46.7 bushels.

Polish—At Sheridan.—Planted May 9th. Ripe August 26th. Yield per acre, 30 bushels.

SASKATCHEWAN FIFE.—Four rows 98 feet long. Planted May 1st. Ripe September 7th. Yield per acre, of straw and grain, 8,284 pounds. Yield of grain, 49 bu.

Saskatchewan Fife—Another Plat.—Planted same. Ripe September 13th. Yield per acre, grain and straw, 9,103 pounds; grain, 44.9 bushels.

Saskatchewan Fife—Another Plat.—Planted same.

September 13th. Yield per acre, straw and grain, pounds; grain, 38.1 bushels.

Saskatchewan Fife—Another plat.—Sown with “Press” April 14th. A poor stand and grain shelled badly being cut. Yield per acre, of grain, 18.3 bushels.

Saskatchewan Fife—At Lander.—Planted April 25th. August 25th. Yield per acre, 20 bushels.

Saskatchewan Fife—At Sheridan.—Planted April 28th. July 30th. Yield per acre, 24 bushels.

Saskatchewan Fife—At Sundance.—Ripe August 7th. Yield per acre, 22.5 bushels.

Saskatchewan Fife—At Wheatland.—Sown April 13th. August 1st. Yield per acre, 15.5 bushels.

PRIDE OF AMERICA.—Four rows 98 feet long. Planted May 1st. Ripe September 5th. Yield of straw and grain, 8,418 pounds; grain, 55.7 bushels.

FIFE SPRING.—Four rows 97 feet long. Planted May 1st. Ripe September 13th. Yield per acre, of straw and grain, 7,417 pounds; grain, 37.1 bushels.

BLOUNT’S No. 10.—Sown with “Press Drill” April 1st. Ripe August 27th. Yield of straw and grain, 3,613 pounds; grain, 21.5 bushels.

Blount’s No. 10—At Wheatland.—Sown April 24th. August 10th. Yield per acre, 32 bushels.

WHITE RUSSIAN.—A little over one-half acre planted May 10th. Ripe August 25th. Yield per acre from the whole plat—straw and grain, 6,799 pounds; grain, 36.4 bushels. Yield from one-eighth acre on south side of plat, which had received a dressing of stable manure at the rate

of twelve loads per acre for two consecutive years, straw and grain, 10,596 pounds; grain, 50.8 bushels.

White Russian—At Sheridan.—Planted April 30th. Ripe August 7th. Yield per acre, 30 bushels.

White Russian—At Wheatland.—Planted March 26th. Ripe August 2nd. Soil treated in four different ways, as follows:

No. I. Not fertilized. Yield per acre, 20 bushels.

No. II. Sixty-six loads well rotted stable manure per acre. Yield, 40 bushels.

No. III. Crop of field peas plowed under when in bloom. Yield, 23 bushels.

No. IV. Crop of red clover plowed under when mature. Yield, 30 bushels.

VELVET CHAFF BLUE STEM.—A little less than one half acre planted April 10th. Ripe August 31st. Yield per acre from the whole plat, straw and grain, 6,143 pounds; grain, 31.5 bushels. Yield from one-eighth acre on south side of plat which had received a dressing of stable manure at the rate of twelve loads per acre for two consecutive years, straw and grain, 7,553 pounds; grain, 35 bushels.

Velvet Chaff Blue Stem—At Sheridan.—Planted April 27th. Ripe August 13th. Yield per acre, 36 bushels.

Velvet Chaff Blue Stem—At Sundance.—Sown April 25th. Ripe August 7th. Yield, 19.5 bushels.

Velvet Chaff Blue Stem—At Wheatland.—Sown April 9th. Ripe August 9th. Yield, 34.4 bushels.

FULTZ WINTER—At Lander.—Ripe July 19th. Soil treated in four different ways, as follows:

No. I. Not fertilized. Yield per acre, 16 bushels.

No. II. Plowing under natural growth of weeds.
Yield, 11.2 bushels.

No. III. Twenty-seven loads stable manure per acre.
Yield, 28 bushels.

No. IV. Crop of field peas plowed under. Yield,
16.5 bushels.

RED OREGON—At Sundance.—Sown April 25th. Ripe
August 7th. Yield per acre, 25 bushels.

NORTHCOTE'S AMBER—At Sundance.—Sown April
1st. Ripe August 2nd. Yield, 28.5 bushels.

WHITTINGTON—At Sundance.—Sown April 21st.
Ripe August 2nd. Yield, 30 bushels.

DEFIANCE—At Wheatland.—Sown April 24th. Ripe
August 10th. Yield, 24 bushels.

OATS.

SURPRISE.—Four rows 97 feet long, planted May 2nd.
Ripe August 15th. Yield per acre, of straw and grain,
115 pounds; grain, 80.1 bushels.

BONANZA.—Four rows 97 feet long, planted May 2nd.
Ripe September 10th. Yield per acre, of straw and grain,
155 pounds; grain, 109.5 bushels.

Bonanza—At Sundance.—Ripe August 6th. Yield,
109.5 bushels.

CHINESE HULLESS—Four rows 97 feet long, planted
May 2nd. Ripe September 10th. Yield per acre, of straw
and grain, 6,406 pounds; grain, 40.5 bushels. Weight, 50
pounds per bushel.

NEW DANISH ISLAND.—One row 9 feet long. Plant-

ed May 2. Ripe September 13. Amount was too small to compute yield with any degree of accuracy.

ARCHANGEL.—One-eighth acre sown with "Press Drill" April 16th. Ripe August 16th. Yield per acre, of straw and grain, 6,543 pounds; grain, 77.2 bushels.

Archangel—At Lander.—Planted April 25th. Ripe August 15th and 20th. Yield, 45 bushels. Two other plats were injured by crickets. They yielded, respectively, 25 bushels and 15 bushels.

Archangel—At Sheridan.—Sown May 8th. Ripe August 16th. Yield, 25 bushels.

Archangel—At Sundance.—Planted April 26th. Ripe August 8th. Yield, 43 bushels.

Archangel—At Wheatland.—Planted April 11th. Ripe July 31st. Yield, 34.2 bushels.

Archangel—Another plat planted April 13th. Ripe July 31st. Yield, 40.1 bushels.

LINCOLN.—Sown with "Press Drill" April 23rd. Ripe August 13th. Yield per acre, of grain and straw, 2,402 pounds; grain, 30.4 bushels.

Lincoln—At Wheatland.—Planted April 24th. Ripe August 10th. Yield, 37.1 bushels.

GOLDEN GIANT SIDE.—Sown with "Press Drill" April 23rd. Ripe August 25th. Yield per acre, of straw and grain, 2,356 pounds; grain, 29.4 bushels.

Golden Giant Side—At Sheridan.—Ripe August 20th. Yield, 45 bushels.

Golden Giant Side—At Sundance.—Ripe August 13th. Yield, 32 bushels.

Golden Giant Side—At Wheatland.—Sown April 18th.

August 17th. Yield, 45.3 bushels. Another plot
yielded 46.6 bushels.

VICK'S 40 LB.—At Lander.—Sown May 17th. Ripe,
August 21st. Yield, 20 bushels. Early, plump and heavy.

RACE HORSE—At Sheridan.—Planted May 11th. Ripe
August 26th. Yield, 38 bushels.

WIDE AWAKE—At Sheridan.—Planted May 11th.
August 26th. Yield, 35 bushels.

WHITE RUSSIAN—At Sheridan.—Sown May 18th.
August 26th. Yield, 25 bushels.

CLYDESDALE—At Sheridan.—Sown May 18th. Ripe
August 26th. Yield, 64 bushels.

Clydesdale—At Sundance.—Sown April 26th. Ripe
August 3rd. Yield, 6½ bushels.

WELCOME—At Sheridan.—Planted May 18th. Ripe,
August 26th. Yield, 52 bushels.

Welcome—At Sundance.—Planted April 28th. Ripe,
August 8th. Yield, 48 bushels.

BLACK TARTARIAN—At Sundance.—Sown May 8th.
August 15th. Yield, 26 bushels.

BARLEY.

TWO ROWED.—Four rows 97 ft. long planted May 1.
August 28. Yield per acre of straw and grain, 9,642
pounds; grain, 92.8 bushels.

HIGHLAND CHIEF.—Four rows 97 ft. long planted May
Ripe August 27. Yield per acre, of straw and grain,
11 pounds; grain, 84.2 bushels.

Highland Chief.—At Wheatland.—Sown April 10.
July 30. Yield 32.1 bushels.

SIX ROWED.—Four rows planted May 1. Ripe August 22. Yield per acre, of straw and grain, 8,091 pounds; grain, 33.5 bushels.

Six Rowed.—Another Plat.—Ripe August 22. Yield of straw and grain, 6,740 pounds; grain 75.8 bushels.

NEW BLACK (Hulless).—Four rows 97 ft. long planted May 1. Ripe August 7. Yield per acre, of straw and grain, 6,069 pounds; grain, 47.2 bushels.

New Black (Hulless).—At Sundance.—Sown May 3. Ripe July 26. Yield 22.5 bushels.

New Black (Hulless) —At Wheatland.—Sown April 25. Ripe August 7. Yield 30 bushels.

CHEVALIER.—One-fourth acre sown April 16th. Ripe August 7. Yield per acre, of straw and grain, 11,236 pounds; grain, 48.2 bushels. We highly recommend this barley for our State. The beards fall off as the grain ripens, and are out of the way by the time it needs to be cut. The grain is large, white, plump and heavy.

MANSHURY.—One-fourth acre planted April 16. Ripe August 10. Yield per acre, of straw and grain, 4,183 pounds; grain, 29 bushels.

Manshury—At Wheatland.—Sown April 10th. Ripe July 30th. Yield 31.2 bushels.

HULLESS—One-half acre sown April 14. Ripe August 10th. Yield 17.5 bushels. This variety is both hullless and beardless. Stand secured was poor.

Hulless—At Lander.—Planted April 24th. Ripe August 11th. Yield 12 bushels.

Hulless.—At Sundance.—Planted May 3rd. Ripe July 26th. Yield 19.5 bushels.

DUCK'S BILL.—At Sheridan.—Sown May 9th. Ripe
August 9th. Yield 24 bushels.

VERMONT CHAMPION.—At Sheridan.—Sown April
. Ripe July 27th. Yield 32 bushels.

Vermont Champion.—At Sundance.—Planted May
Ripe August 8th. Yield 33 bushels.

MANCHESTER.—At Sheridan.—Sown April 28th. Ripe
26th. Yield 32 bushels.

RYE.

WINTER.—One-half acre. Ripened August 7th.
Yield of straw and grain, 3,461 pounds; grain, 18.4
bushels.

Winter.—At Lander.—Ripe July 19th. Yield 22
bushels.

Winter.—At Sheridan.—Ripe August 18th. Yield
20.5 bushels.

Winter.—At Sundance.—Ripe July 25th. Yield 18.5
bushels.

Winter.—At Wheatland.—Ripe July 23rd. Yield
20.5 bushels.

SPRING.—One-half acre planted April 13th. Ripe
August 15th. Yield per acre 34.3 bushels.

Spring.—At Sheridan.—Ripe August 26th. Yield
20.5 bushels.

Spring.—At Wheatland.—Sown April 10th. Ripe
28th. Yield 20.2 bushels.

Both spring and winter rye at Laramie produced

large, plump grain, the spring rye giving an especially heavy crop.

CORN.

MINNESOTA KING.—At Sheridan.—Yield per acre 40 bushels.

Minnesota King. —At Wheatland.—Planted May 10th. Ripe September 11th. Yield 37.1 bushels.

FLOUR CORN.—At Sundance.—Planted May 14th. Ripe September 10th. Yield 40 bushels.

ANGEL OF MIDNIGHT.—At Wheatland.—Planted May 14th. Ripe September 15th. Yield 24.9 bushels.

DAKOTA DENT.—At Wheatland.—Planted May 12th. Ripe September 14th. Yield 9.7 bushels.

RIDE OUT CORN.—At Wheatland.—Planted May 15th. Ripe September 15th. Yield 32.4 bushels.

NEW HONEY SWEET CORN.—At Wheatland.—Planted May 15th. Crop ripened for seed. It was ready for market August 2nd. Yield of seed per acre, 3,200 pounds.

BROOM CORN. (Wheatland.)

JAPANESE.—Planted May 12th. Harvested Sept. 10th. Yield 832 pounds. Length of straw or brush, 14 inches. Pale yellow. Quality good.

IMPROVED EVERGREEN.—Planted May 12th. Harvested September 20th. Yield 1,712 pounds. Length of brush 15 inches. Bright green. Has proved a good yielder and of first-class quality for two seasons.

CALIFORNIA GOLDEN.—Planted May 12th. Harvested September 12th. Yield 1600 pounds. Length of brush 14 ins. Bright yellow. Of good quality.

LITTLE DWARF.—Planted May 12th. Harvested September 15th. Yield 560 pounds. Grows a short, thick stem, 8 inches long. Bright yellow.

FLAX.

The fact that flax can be raised successfully in Wyoming has been demonstrated. New Russian produced 15.6 bushels of seed per acre. The same variety grown for hay produced a good crop. As it has not yet been tested for fiber, its value can not be reported.

PEAS.

Table VII gives our results with garden peas. The green peas were picked off for market during the season, and the latter part of the season those remaining on the vines were allowed to ripen for seed. Each variety gave the yield indicated of seed peas in addition to the green peas that had been picked. Earliest varieties were Tom Thumb, Green Early Premium Gem, Extra Early Daniel O'Rourke, and Alaska. The Telegraph and Telephone are two of the best varieties for the table.

FIELD PEAS.—At Wheatland two varieties were grown: Scotchman, planted April 2, was ripe August 27th, and yielded 21.3 bushels of seed. White Canadian, planted April 2nd, ripe August 20th. Yield 24.6 bushels.

Table VII. PEAS.

1894

LARAMIE EXPERIMENT STATION.

Number.	NAME OF VARIETY.	Date of Bloom.	Ready for Market.	Yield per Acre.	
				Pounds Green.	Pounds Seed.
1	Sterling	July 10	Aug. 20	—	1,003.8
2	Melting Sugar	" 2	July 25	1,234.4	922.4
3	Telegraph	" 2	" 26	5,520.9	352.7
4	Blue Imperial Dwarf	" 2	" 26	2,774.0	922.4
5	Black-eyed Marrowfat	" 10	Aug. 1	2,089.0	1,139.5
6	Bliss' Ever-bearing	" 2	July 26	3,330.2	1,030.9
7	Yorkshire Hero	" 2	" 26	7,060.7	678.2
8	Pride of the Market	" 10	Aug. 11	1,668.5	841.0
9	Bliss' Abundance	" 2	July 28	3,554.0	922.4
10	Dwarf Wrinkled	" 10	—	—	1,410.8
11	Saxton's Alpha	June 25	July 28	630.8	1,112.3
12	Tom Thumb	July 2	" 12	1,648.1	651.1
13	Prince of Wales	" 2	Aug. 6	5,208.9	542.7
14	White Marrowfat	" 10	—	—	1,112.3
15	Telephone	June 25	Aug. 7	3,899.9	705.4
16	Champion of England	July 2	" 10	2,889.4	488.8
17	McLean's Advancer	June 25	—	—	841.0
18	Horsford's Market Garden	July 2	Aug. 15	2,930.0	1,166.6
19	American Wonder	June 25	—	—	868.2
20	McLean's Little Gem	July 2	Aug. 1	2,563.8	1,030.9
21	Stratagem	" 10	" 10	5,982.2	406.6
22	Royal Dwarf Marrowfat	" 17	" 15	854.6	1,112.3
23	Extra Early Premium Gem	June 25	July 12	2,760.5	135.6
24	Extra Early Daniel O'Rourke	" 18	" 12	4,015.2	1,422.1
25	Lee's Earliest	" 18	" 12	4,306.9	162.3
26	Alaska	" 20	" 12	135.6	1,248.6
27	Cleveland's Rural New Yorker	" 19	" 18	854.6	976.7
28	Renown	" 21	—	—	542.7
29	The Echo	July 10	—	—	833.3

BEANS.

Twenty varieties were grown upon the Laramie farm. Few of these matured seed.

Dwarf Horticultural. Ready for market August 6th. Seed ripened.

Ivory Pod Wax. A few seed ripened

Best of All. Ready for market August 6th. Did not mature seed.

Golden Eyed Wax. Ready for market August 6th. Did not mature.

Golden Butter Pole. A few seed ripened.

German White Wax. Ready for market August 30th. Did not mature.

California Tree. A few ripened.

Detroit Wax. Ready for market August 8th. Matured.

Flageolet Wax. Ready for market August 8th. Matured.

Early Long Yellow Six Weeks. Ready for market August 8th. Seed matured.

Refugee. Ready for market August 8th. Matured.

Early White Valentine. A few ripened.

Crystal Wax. Ready for market September 1st. A few ripened.

Canadian Wonder. Ready for market August 9th. Three-fourths of crop matured.

Early Red Valentine. In bloom at time of frost, August 27th.

Black Wax. Ready for market at time of frost, August 27th.

Kentucky Wonder. In bloom at time of frost, August 27th.

Burpee's Bush Lima. Budded to bloom at time of frost, August 27th.

- 19 Burpee's New Stringless Green Pod Bush. Ready for market at time of frost, August 27th.
 20 Boston Small Pea. In bloom at time of frost, August 27th.
 Boston Small Pea Bean at Wheatland. Planted May 10th. Ripe Sept. 15th. Yield 15 bushels.

CABBAGE.

But a small per cent. of the plants set out made heads. The column giving the per cent. marketable indicates the per cent. of the plants set out which made marketable heads. There was practically no loss from transplanting. Lee's Excelsior did much better than any other variety, giving the largest yield, largest heads, and the largest per cent. of plants that produced heads.

	Per cent. Marketable.	Yield per Acre in lbs.	Weight of 12 Largest in lbs.
1 St. Denig's Large Drumhead.....	26	3,378	45.7
2 Lee's Wonderful	45	11,308	91.3
3 Lee's Excelsior.....	65	16,151	94.6
4 Red Erfurt.....	5	899	41
5 Large Red Dutch	11	1,231	25.2
6 Prime Flat Dutch	33	4,066	42.7
7 Felder Kraut	49	5,684	31.2
8 Large Drumhead.....	18	2,257	25.7
9 Late Flat Dutch.....	8	786	21.6

KOHL RABI.

Every plant set out grew and produced a head. They were of good size and of the best quality. The white and purple were planted together, and both varieties did equally well. Yield 15,475 pounds per acre. Weight of 12 largest, 72.3 pounds.

CAULIFLOWER.

Plants set in the open ground produced a late crop. One per cent. of plants which produced heads was small. They were set out June 15th and harvested October 8th. Forty plants of the first mentioned produced 41 heads, and the second 116 plants were set out, producing 68 heads.

		Yield per Acre.	Weight of 12 Largest Heads.
Snow Ball.	Seed from P. H. & Co.	2,409	25.5
Snow Ball.	Seed from U. S.	2,588	27.2

Heads small but firm, white and tender.

COST AND PROFIT

OF

GROWING WHEAT.

This is the second season that the record upon the test acre of wheat, to determine cost and profit, has been carried out upon all the experiment farms. Attention is called to the first report, in Bulletin No. 17. The table giving the results for 1893 is inserted with Table VIII, showing the cost and profit last season. Upon larger areas the cost of producing the crop would be much less. In 1893, Gov. Shortridge of North Dakota stated that by the use of improved machinery he had reduced the cost of growing wheat to \$4.50 and \$5.00 per acre. The average profit for 1893 was \$8.86 per acre; in 1894 the average profit from the six trials shown in the table was \$8.56 per acre.

PLACE.	VARIETY.	Yield.	Price per Pound.	Value of Crop.	Cost of Seed.	Labor Putting in Crop.	Cost of Irrigation.	Cost of Harvesting.	Threshing.	Total Cost.	Profit.
Lander	Spring Fife	lbs. 1,440	cts. 11½	\$21.60	\$1.86	\$5.00	\$1.00	\$3.50	\$2.00	\$13.36	\$ 8.24
Sheridan	Saskatchewan Fife	1,860	1	18.60	Cost of raising crop.	"	"	"	"	11.71	6.89
Sundance	{ Red Oregon.	1,038	{	22.38	"	"	"	"	"	7.75	14.63
	{ Velvet Chaff Blue Stein	1,200	{	18.98	"	4.50	4.00	2.00	"	13.30	5.68
Wheatland	White Russian	1,898	1								

TABLE VIII. COST AND PROFIT OF GROWING WHEAT. 1894

PLACE.	VARIETY.	Yield.	Price per Bushel.	Value of Crop.	Cost of Seed.	Labor Putting in Crop.	Cost of Irrigation.	Cost of Harvesting.	Threshing.	Total Cost.	Profit.
Laramie	White Russian	bush'ls. 35	cts. 1	\$21.0	\$1.75	\$3.50	\$2.25	\$1.60	\$2.10	\$11.20	\$9.80
Lander	{ Velvet Chaff	20	1	12.00	1.72	putting in and raising crop.	"	"	"	10.27	1.73
Sheridan	Saskatchewan Fife	36	1	21.00	Cost of raising crop.	"	"	"	"	13.06	8.54
	{ Red Oregon.	24	1	14.40	"	"	"	"	"	10.80	3.60
Sundance	{ Velvet Chaff	40	1	24.00	"	"	"	"	"	7.30	16.70
	{ Northcote's Amber	40	1	24.00	"	"	"	"	"	13.00	11.00
Saratoga	Saskatchewan	40	1								
Wheatland	White Russian	40	1								

SMALL FRUITS.

Only a short report of the results with fruits at Laramie is here given. So many varieties are being tested at the Sub-Stations that abundant material will be at hand for a fruit bulletin when the notes for 1895 are completed.

On the Laramie Experiment Farm, thus far, strawberries, raspberries and grapes have not been a success, as they have died during the dry winters.

The Laramie Farm, situated on the open prairie, is so exposed that the conditions are as unfavorable as could well be obtained. Taking this fact into account, the results so far obtained are encouraging. The greatest obstacle is our high winds. When wind-breaks have been grown as a protection, many of the smaller fruits will, without doubt, be successful.

The entire absence of fruits in this region makes any which promise success worthy of extended trial and report.

Currants are the only fruit which have come into bearing as yet. They were set out in May, 1892, the varieties being Red Cherry, White Grape, Fay's Prolific, Black Naples, Crandall, and Long Bunch Holland. All have lived through the winters without protection. The Red Cherry

PLATE IV.



RED CHERRY CURRANT.

in Plate IV bore the heaviest crop, with White and Fay's Prolific as second best yielders. The varieties bore only a small amount of fruit. The all is a rapid grower and would be valuable here for ental purposes. Currants should be protected from nd, as when in bearing the weight of the fruit, com- with the force of the wind, breaks the branches. f Gooseberries, Houghton and Industry have died. plants of Smith and Chas. Downing are still alive, ey have made small growth and show no tendency to Japanese Wineberry and Juneberry have lived with- nter protection.

UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,

LARAMIE, WYOMING.

BULLETIN NO. 23.

MAY, 1895.

NOTES ON CLIMATE.

BY THE METEOROLOGIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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NOTES ON CLIMATE.

On account of the mean annual temperature of the year 1894 being lower than the preceding year the casual observer would infer that the climatic conditions for the growth of crops were not as good. But we find that the low temperature was due to the extreme cold weather of January, February, November and December, while the months of April, May, June, July and August were much warmer than the corresponding months of 1893, and 89 per cent. of the annual precipitation at Laramie occurred between April and October. The temperature and precipitation during the growing months were quite favorable on the Laramie Plains. Nearly the same relative conditions prevailed elsewhere throughout the State.

There were no heavy storms in 1893 or 1894, at Laramie, as in the two preceding years in the month of June, as well as the annual amount of precipitation. During the year of 1893 the rain-fall throughout the eastern part of the State was very small, the amount at Laramie being only 1.5 inches, the smallest amount on record for this region, or a little over one-fourth of the normal precipitation as-

certained from the records kept at Ft. Sanders, three miles south of Laramie, from the year 1869 to 1878, the average precipitation being for that time 12.92 inches. In 1894 there were only 7.63 inches at this Station, being some over half the normal amount, but nearly all of this fell during the growing season. There were 6.84 inches rain-fall from April 1st to October 1st, distributed as follows:—April, 1.51 inches; May, 0.42 inches; June, 0.64 inches; July, 1.41 inches; August, 1.26 inches; and September, 1.60 inches. The greatest annual precipitation recorded in the State by the Observers who report to us, was from Sundance—19.99 inches. In the month of June 4.16 and in May 3.18 inches fell at that place.

The largest monthly rain-fall recorded was at Inyan Kara during the month of June, viz: 5.01 inches.

At Laramie the greatest amount during any single storm was 0.69 inches in July. At Lander, 1.11 inches in March. At Saratoga, 0.80 inches in March. At Sheridan, 1.00 inch in March. At Wheatland, 1.25 inches in June and July. At Sundance 1.62 inches in May. Laramie, Sundance and Wheatland combined had 37.75 inches precipitation in 1894 and 26.82 inches in 1893. At Laramie and Wheatland it was nearly double the preceding year, while at Sundance it was nearly 21 per cent. more than in 1893. At Lander, Saratoga and Sheridan it was 35.94 inches against 38.74 inches the preceding year, each station sharing about equally the small difference.

The mean relative humidity or per cent. of moisture at Laramie was lower than the two previous years, being 63.7 in 1892 and 56.9 in 1893, and 56.4 in 1894. June was the driest month, with only 43.4, and May, October and No-

ber were nearly as dry. The mean dew-point was ne higher.

EVAPORATION AT LARAMIE.

Evaporation from water surface is measured by means a Hook Gauge, measurements being taken every day t the water is not frozen. A tank of galvanized iron ding one cubic meter of water is used. Care is taken to ep the tank nearly full, that evaporation may not be in- ferred with. Evaporation can not be accurately obtained ring the winter months. For six months from April 26th October 27th, it was 37.166 inches. During the time water was not frozen, it was as follows:

April 26 to 30	0.906
May	6.060
June	7.492
July	6.690
August	6.276
September	6.436
October 1 to 27	3.306

EXPLANATION OF TABLES.

Temperature.—The mean temperature at the Experi- ent Farms is taken from the maximum and minimum read- ys. At Bates' Park (Freeland) the observations are taken Mrs. C. M. Cheney three times daily, at 7 a. m., 2 p. m. d 9 p. m., and the mean for each day is found by the formula

$$\frac{2+9+9}{4}$$

At Inyan Kara the observations are taken by S. A. ung.

At Dobin Springs (Casper) the observations are taken Martin J. Gothburg.

At both places readings are taken twice daily, at 7 a. m. and 7 p. m. The mean is obtained by dividing the sum of the daily readings by two. This probably gives results a little too high for summer months, but nearly as close to the actual mean in the cold months as that from the maximum and minimum readings, since during these months the minimum temperature usually occurs near 7 o'clock a. m., and the maximum between 2 and 3 o'clock p. m. The daily range of temperature is the difference between the maximum and minimum readings.

In Table IV the records of the Anemometer are not complete, as the instrument was out of order for nearly a month. Consequently we recorded the velocity for all the months except September, but the annual mean we could not give.

The precipitation at each Experiment Farm given in Table V is observed by the Superintendent. The record for Cheyenne was furnished by the Chief of the State Weather Service. For Bates' Park (Freeland) by Mrs. C. M. Cheney, for Trelona by James Jackson, for Inyan Kara by S. A. Young, for Hat Creek by Andrew Falconer, for Sybille by A. E. Bridger, for Dobin Springs near Casper by Martin J. Gothburg. The observations at Laramie were made by the Assistant Meteorologist of the Experiment Station, Fred Nelson. Thanks are due to all these observers for the interest taken and time spent in furnishing the records.

* Instruments broken. No record kept for November and December.

TABLE II. DAILY RANGE OF TEMPERATURE. 1894

PLACE.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Laramie	19.9	16.2	29.4	39.1	52.3	55.8	63.2	62.2	51.8	44.4	22.8	21.5	39.9
Lander	21.5	17.9	32.6	43.5	55.5	60.9	66.7	66.7	52.9	45.7	36.9	20.3	43.4
Saratoga	18.2	13.3	29.6	40.0	51.4	56.6	64.5	62.9	50.6	42.6	34.5	19.6	40.3
Sheridan	12.4	9.3	27.7	47.5	55.5	63.2	68.3	68.5	54.3	45.6	38.1	22.6	42.8
Sundance	13.2	13.8	26.6	42.2	54.0	62.1	66.7	68.9	54.2	44.9	33.7	27.1	42.3
Wheatland	25.9	23.1	36.7	47.8	58.4	64.1	71.4	70.7	63.2	48.9	*	*	
Freeland			28.7	39.2	51.0	57.0	65.1	65.5	49.6	42.3	32.4	24.4	
Inyan Kara			27.9	43.8	58.3	67.7	70.7	72.5	57.0	45.8	32.2	20.8	
Little Horse Crk			30.9	46.5	60.9	66.7	71.1	68.4	57.4	45.0	36.8	24.0	
Dobin Springs						65.7	71.3	72.1	57.4	50.0	39.5	29.6	

PLACE.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Laramie	19.9	23.1	19.8	23.2	26.3	28.7	29.2	30.0	28.8	26.5	26.7	23.7	25.5
Lander	24.3	23.8	21.8	22.5	24.1	23.0	34.3	35.9	29.2	33.3	33.7	27.2	27.8
Saratoga	22.8	26.2	20.1	25.1	28.0	29.4	31.4	34.7	29.1	42.8	28.7	29.4	29.0
Sheridan	25.3	30.6	24.5	29.1	29.7	26.7	32.5	38.9	32.5	32.5	27.0	30.3	30.0
Sundance	18.9	23.6	24.1	21.3	26.4	25.6	29.6	30.5	26.8	21.6	19.8	19.1	23.9
Wheatland	32.9	30.6	22.8	25.2	28.1	25.8	31.3	30.0	37.8	34.6	*	*	29.9

* November and December missing. Instrument broken.

Wyoming Experiment Station.

TABLE III.
WEEKLY MEANS OF SOIL TEMPERATURES
LARAMIE, 1894.

WEEK ENDING--	Air Tem- perature.	3 Inches	6 Inches	12 Inches	24 Inches	36 Inches	72 Inches
January 6.....	14.6	20.9	23.0	26.1	30.5	33.3	39.0
" 13.....	18.2	19.8	20.9	23.0	27.8	31.6	38.6
" 20.....	21.8	25.0	26.2	27.4	29.4	31.2	37.6
" 27.....	13.3	20.3	21.9	24.1	28.0	30.6	36.9
February 3.....	16.0	22.2	23.6	24.9	27.4	29.8	36.3
" 10.....	14.8	20.3	22.0	24.1	27.2	29.5	35.7
" 17.....	10.6	17.3	19.0	21.0	25.2	28.5	35.0
" 24.....	5.7	20.0	21.4	23.1	26.1	28.4	34.6
March 3.....	27.3	28.3	28.4	26.6	26.7	28.5	34.3
" 10.....	23.6	29.5	30.2	29.5	29.5	30.1	34.4
" 17.....	36.7	37.9	37.7	34.8	31.7	31.4	34.4
" 24.....	18.9	33.0	34.6	34.7	34.3	34.1	34.3
" 31.....	24.7	32.5	33.1	32.9	33.2	33.8	35.8
April 7.....	35.0	36.9	37.6	36.3	34.9	34.8	36.1
" 14.....	36.4	41.0	42.1	41.1	38.7	37.4	36.9
" 21.....	34.9	39.8	40.6	40.4	40.0	39.3	38.1
" 28.....	44.8	46.4	47.2	45.7	41.6	40.2	38.9
May 5.....	41.0	45.9	47.5	47.1	44.3	43.3	40.2
" 12.....	51.0	54.5	55.6	53.9	48.8	46.5	41.8
" 19.....	50.7	54.3	55.2	54.6	51.3	49.4	43.7
" 26.....	49.6	54.5	56.4	55.7	52.1	50.4	45.3
June 2.....	53.1	57.4	58.1	57.1	54.2	52.3	46.6
" 9.....	52.7	57.7	58.5	57.6	54.9	53.1	47.3
" 16.....	59.6	63.2	63.6	61.5	57.3	54.9	48.9
" 23.....	58.8	64.1	64.8	62.6	59.1	56.9	50.4
" 30.....	60.8	63.7	64.3	62.6	59.6	57.8	51.0
Forward	874.6	1,007.4	1,033.5	1,028.4	1,003.8	1,017.1	1,030.3

TABLE III—Continued.

WEEK ENDING—	Air Tem- perature.	3 Inches	6 Inches	12 Inches	24 Inches	36 Inches	72 Inches
Forward	874.6	1,007.4	1,033.5	1,028.4	1,003.8	1,107.1	1,030.5
7.....	60.2	65.9	66.1	64.8	61.3	59.0	52.6
14.....	65.6	69.4	70.7	68.5	63.3	60.3	53.6
21.....	62.0	67.8	69.2	67.4	63.9	61.5	54.7
28.....	64.8	70.1	70.9	68.5	64.4	61.8	55.5
August 4.....	59.9	62.4	64.7	65.2	63.7	62.1	56.2
11.....	61.8	64.2	65.6	64.5	61.8	60.3	56.2
18.....	63.6	69.4	70.6	68.1	64.2	61.7	56.4
25.....	59.8	67.8	69.3	67.5	64.5	62.5	56.9
September 1.....	57.7	67.9	69.3	67.3	64.4	62.4	57.3
8.....	51.6	60.5	62.5	63.2	62.5	57.4	61.8
15.....	47.2	53.9	55.3	56.5	57.4	57.9	56.7
22.....	49.9	56.5	57.8	57.1	56.1	56.1	55.5
29.....	47.4	55.0	56.7	56.8	56.2	55.9	54.7
October 6.....	42.1	47.5	49.2	50.4	52.1	53.3	54.0
13.....	40.0	46.5	48.0	48.5	50.0	50.9	52.7
20.....	43.6	49.5	50.6	50.1	50.0	50.3	51.7
27.....	41.2	46.0	47.3	47.9	48.8	49.5	50.9
November 3.....	32.6	38.5	40.7	42.7	45.5	47.4	50.1
10.....	36.0	40.0	41.4	42.1	43.7	45.2	48.9
17.....	30.5	37.3	38.7	40.4	42.7	44.3	47.9
24.....	30.9	32.3	34.0	36.1	39.6	42.1	45.3
December 1.....	31.8	35.5	36.6	37.3	39.1	40.9	45.6
8.....	22.9	28.2	29.6	32.1	36.3	39.1	44.6
15.....	20.3	25.5	27.1	29.4	33.6	36.7	43.3
22.....	30.5	29.4	30.3	30.9	33.2	35.4	42.0
29.....	5.7	23.1	24.7	28.1	32.4	35.1	41.0
Sums.....	2,034.2	2,316.5	2,380.4	2,379.8	2,364.5	2,366.2	2,379.6
	39.1	44.5	45.8	45.8	45.5	45.5	45.7

Table IV. LARAMIE. 1894

MONTH.	RELATIVE HUMIDITY.			DEW-POINT.			BAROMETER.			WIND.			TERRESTRIAL RADIATION.		
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Greatest.	Miles.	Direction.	Highest.	Lowest.	Mean.
January.....	100.0	34.8	72.4	23.5	-17.0	8.7	23.15	22.531	22.887	48	11,234	S. W.	8.8	1.5	4.8
February.....	100.0	27.7	66.1	19.2	-18.0	3.3	23.254	22.554	22.920	44	9,927	S. W.	7.7	0.4	4.5
March.....	100.0	21.6	64.5	34.2	-9.5	14.8	23.292	22.552	22.919	60	12,265	S. W.	8.3	0.3	3.6
April.....	100.0	20.7	61.3	35.1	7.7	23.9	23.276	22.675	22.992	66	11,487	N. W.	7.5	0.3	3.1
May.....	86.3	13.5	49.7	44.5	9.0	29.3	23.315	22.705	23.058	60	12,137	S.	6.5	0.5	3.1
June.....	87.0	10.6	43.4	48.2	12.6	32.8	23.236	22.827	23.062	66	9,916	S. W.	5.7	1.0	3.3
July.....	97.6	17.3	51.5	56.2	24.4	42.8	23.389	22.971	23.254	60	7,415	S. E.	7.7	1.5	4.3
August.....	80.0	13.4	53.8	53.2	14.7	41.4	23.377	23.105	23.248	40	7,890	S. W.	8.5	2.3	5.0
September.....	96.0	18.2	52.3	44.2	10.3	30.3	23.356	22.748	23.106	*	*	S. W.	11.0	0.5	5.6
October.....	93.2	15.6	48.4	37.2	1.0	20.2	23.355	22.728	23.061	60	10,729	S.	10.5	2.5	6.0
November.....	100.0	20.7	47.8	32.0	-10.0	14.4	23.317	22.746	23.118	56	10,326	S. W.	8.4	1.9	5.0
December.....	100.0	21.6	65.8	25.5	-23.0	8.5	23.341	22.575	23.018	50	8,132	S. W.	9.0	0.5	4.8
Summary.....			677.0			270.4			276.643						53.1
Mean.....			56.4			22.5			23.054						4.4

* Instrument broken during part of September.

PLACE.	January	February	March	April	May	June	July	August	September	October	November	December	Total
Laramie	0.03	0.10	0.29	1.51	0.42	0.64	1.41	1.26	1.60	0.09	0.05	0.23	7.63
Lander	0.16	1.10	4.14	1.07	0	0.20	0.97	0.41	2.29	0.03	0.32	0.03	10.72
Saratoga	0.60	0.90	2.30	1.87	0.30	0.92	1.96	0.80	1.43	0.25	0.40	1.00	12.73
Sheridan	0.70	0.72	3.15	1.50	0.64	2.44	1.28	0.11	0.95	Trace	0.80	0.20	12.49
Sundance	1.10	0.75	1.50	0.82	3.18	4.16	2.01	0.37	0.91	2.85	0.98	1.36	19.99
Wheatland	0.50	0.30	1.08	0.46	0	2.17	2.02	0	0.70	0.70	0.70	1.50	10.13
Cheyenne	0.20	0.72	0.93	1.64	1.24	0.64	3.25	2.17	1.23	*	*	*	
Bates Park	*	*	4.35	2.10	0.80	1.45	0.60	0.90	1.80	0.55	0.30	0.25	
(Freeland)	*	*	1.80	0.71	2.52	5.01	2.78	0.30	*	*	0	0.12	
Inyan Kara	0.10	0.32	0.32	1.10	1.22	2.90	4.07	1.18	0.70	0.15	0.30	0.90	13.26
Hat Creek	*	1.28	1.35	2.80	1.91	0.84	1.65	2.92	1.14	0.45	1.36	0.58	
Sybilie	*	0.19	1.72	*	0.35	*	*	*	*	*	*	*	
Tretona	†	†	†	†	†	0.49	2.01	0.33	2.43	0.52	0.70	0.55	
Dobin Springs ..	†	†	†	3.28	0.97	0.72	3.02	1.05	0.86	0.03	0.60	0.18	
Little Horse Crk	*	*	0.48										

* These months not reported. † Commenced observations in June.

GENERAL SUMMARY.

Highest Temperature—Laramie, 87.6, July 11; Lander, 94, July 10; Saratoga, 88, July 10; Sheridan, 96, August 27; Sundance, 94, July 30; Wheatland, 99, July 11.

Lowest Temperature—Laramie, —27, December 19; Lander, —24, February 20; Saratoga, —29, December 19; Sheridan, —36, January 24; Sundance, —28, January 26; Wheatland, —22, January 26.

Highest Monthly Range of Temperature—Laramie, 30, August; Lander, 35.9, August; Saratoga, 42.8, October; Sheridan, 38.9, August; Sundance, 30.5, August; Wheatland, 37.8, September.

Lowest Monthly Range of Temperature—Laramie, 19.9, January; Lander, 21.8, March; Saratoga, 20.1, March; Sheridan, 24.5, March; Sundance, 18.9, January; Wheatland, 22.8, March.

Highest Annual Mean Temperature; 43.4, Lander.

Lowest Annual Mean Temperature; 39.9, Laramie.

Average Mean Temperature for the following Experiment Farms—Laramie, Lander, Saratoga, Sheridan,

undance; 41.7. The observations at Wheatland interrupted on account of broken instrument.

reatest Annual Precipitation—19.99 inches at Sun-

lowest Annual Precipitation—7.63 inches at Laramie.

verage Precipitation in 1894 for the places furnishing
ete records as given in the tables, 12.42 inches.

illing Frost at Saratoga June 14.

ight Frost at Laramie May 24 and 25.

ail and Snow at Sheridan April 18.

OTHER OBSERVATIONS AT LARAMIE.

ighest Terrestrial Radiation—11.0, September 27.

lowest Terrestrial Radiation—0.0, April 12 and April

lowest Relative Humidity—10.6, June 26.

ean Relative Humidity for the year, 56.4.

ighest Dew-Point—56.2, July 3.

lowest Dew-Point—23.0, December 28.

ean Dew-Point for the year—22.5.

reatest Monthly Evaporation—7.492 inches.

total Evaporation for six months from April 26 to
er 27—37.166 inches.

Highest Barometer—23.389, July 1.

Lowest Barometer—22.531, January 3.

Mean Barometer for the year—23.054.

Prevailing direction of the wind—South-west.

Greatest Velocity of Wind—56 miles per hour, April 15, June 6.

Greatest Number of Miles traveled in one month—12,265 miles, March.

Greatest Number of Miles in one day—918, June 5.

The Anemometer being out of order during a part of September, we would refer you to Table No. 5, for other data concerning the wind.

UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,

LARAMIE, WYOMING.

BULLETIN NO. 24.

AUGUST, 1895.

WATER ANALYSES.

BY THE CHEMIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

THE S. A. SPROUL CO., PRINTERS AND BINDERS, CHEYENNE, WYO.

Wyoming Agricultural Experiment Station.

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WATER ANALYSES.

E. E. SLOSSON.

Water as found in nature is never pure, but always contains in solution a greater or less amount of foreign substances derived from the air and from the soil through which it runs. Whether the dissolved matter is beneficial, poisonous or neither, depends on the use to which the water is to be put. Substances which are obnoxious in drinking water may be of benefit in irrigation water, and a water which could not be used in a boiler may be of great value for domestic purposes. The natural waters of Wyoming are different in character, varying from the melted snow in mountain brooks to the saturated solutions of alkaline salts in the plains, that it is desirable to determine their composition before making plans for their use. It is of particular importance that the character of the water used for irrigation should be ascertained, in order to know whether it is suited to the purpose, or, if it is not of good quality, how to use it without injury to the land. The present bulletin includes analyses of all the irrigation waters obtained on the Experiment Stations in Wyoming, and com

parative analyses of the water of the entering and was weirs on the Laramie farm for two seasons. A number of analyses made during the past three years, of spring and well waters used for domestic or mechanical purposes and of mineral waters collected by the Station, have been included.

THE INTERPRETATION OF WATER ANALYSES.

While to understand the full significance of a water analysis requires a considerable knowledge of chemistry yet the acquirement of the meaning of a very few terms and attention to a few simple principles will enable anyone to determine the fitness of a water for any particular purpose or the relative value of different samples.

The mineral matter taken up by water in its passage through the ground consists chiefly of a class of substances known as salts from their resemblance to common salts. Salts consist of two parts; an electro-positive or basic component and an electro-negative or acid component. On dissolving in a large quantity of water the salts separate into these two parts; so, for example, potassium sulphate is not present in a mineral water as K_2SO_4 but as K_2O and SO_4 . The amount of these two components is what is actually determined in a water analysis and the only correct method is to report the results in that form, as is now the custom in purely scientific work. Since, however, to adopt this way of stating results in a popular bulletin would make it less intelligible to the ordinary reader, as well as render comparison with previous analyses more difficult, it has been thought necessary in this case to follow the old method and report bases and acids as oxids where possible.

As we are more familiar with salts than with acids and bases, it is customary to report them also in combination as salts. The manner of combining them is purely arbitrary, since a natural water does not contain separate salts but merely their components in a state of equilibrium dependent on the kind and relative amounts of the compounds, the degree of dilution and the temperature. Any mixture of salts, if it contains the same amount of basic and acid components, would, if dissolved, produce exactly the same mineral water. We can easily see, then, the absurdity of statements frequently found in advertisements of mineral waters, such as, for example, "The lithia in this water is in the form of a carbonate and is therefore of more value than where it exists as chlorid", for whether it is reported as carbonate or chlorid depends merely on the fancy of the analyst. An analysis stated in the form of salts means simply that the given weight of the salts dissolved in the given volume of pure water would give a mineral water identical with that analyzed. Unfortunately, chemists are not agreed as to the best way of reporting the analytical results, so analyses calculated in different ways cannot be compared without recalculating.

There is also great diversity in the units used in stating water analyses. Since in many analyses the salts are reported as so many grains in one United States gallon, the analyses in this bulletin are in some cases calculated in that form to facilitate comparison. This is supposed to be a simple form, but as a matter of fact very few persons have a definite mental conception of what is the proportion of, say, ten grains to a gallon, or, indeed, could even tell how many grains of water there are in a gallon. It is much

easier for anyone to comprehend the results if reported the metric system as grams per liter, for, since one liter pure water weighs one thousand grams, it is sufficiently accurate for all practical purposes to say that *grams per liter is the same as parts per thousand*. Thus, if a water contains two grams per liter of total solids we see at once that there are two-tenths per cent. of mineral matter, or two pounds in one thousand pounds of the water. This is not strictly accurate, for, of course, a liter of water containing dissolved mineral matter must weigh more than one thousand grams, but the difference is too slight to be ordinarily taken into consideration. In dealing with a strong mineral water it is more exact to use the specific gravity, for in the case of water of 1.002 specific gravity, grams per liter is parts per weight in 1002 parts instead of 1000.

SUITABILITY OF WATER FOR VARIOUS PURPOSES.

Domestic Purposes. The most objectionable ingredient in drinking water is organic matter, as it indicates previous contamination with decomposing animal or vegetable remains and the possible presence of disease germs. Organic matter is generally estimated by determining the amount of ammonia in a free state and that formed by the decomposition of albuminoids. The Laramie City water is the only one analyzed in this way, as most of the other waters were taken directly from springs or artesian wells where there was no reason to suspect organic matter in injurious amounts.

The character of the mineral matter in drinking water is not usually of importance unless the quantity should be so great as to have a medicinal effect, as in the case of alkaline

ers. For other domestic uses such as cooking and washing the presence of considerable amounts of calcium (lime) and magnesium salts is objectionable, as they make the water hard. If these salts are carbonates they may be partly removed by boiling with water, by which process they are rendered insoluble and the water may be drawn off from the deposit. Boiling with sodium carbonate (sal soda) precipitates almost all of the calcium and magnesium salts.

Water for Steam Boilers. Mineral salts act injuriously on boilers in two ways; by corrosion of the interior and by deposition of scale. Chlorids, and especially magnesium chlorid, are the most active agents in corroding boilers, for they decompose slightly on heating and give off acid fumes which attack the exposed iron. The amount of scale-forming ingredients in a water may be estimated by summing up separately the difficultly soluble and the easily soluble salts according to the following scheme:

Easily Soluble—	Difficultly Soluble—
Sodium chlorid, NaCl (common salt)	Silica, SiO_2
Sodium sulphate, Na_2SO_4 , (Glauber's salt)	Calcium carbonate, CaCO_3 , (limestone)
Sodium carbonate, Na_2CO_3 , (sal soda)	Calcium sulphate, CaSO_4 , (gypsum)
Potassium sulphate, K_2SO_4	Magnesium carbonate, MgCO_3 .
Potassium chlorid, KCl	
Magnesium chlorid, MgCl_2	
Magnesium sulphate, MgSO_4 , (Epsom salt).	

On evaporating water containing these the difficult soluble salts will first be thrown down and, if not frequently removed, will collect in the boiler and form a hard coating or shell which hinders the transmission of heat and may cause an explosion. Calcium sulphate is rather worse than calcium carbonate, for the latter becomes largely insoluble as soon as the water is heated and collects at the bottom as a loose powder which can be removed by "blowing off" while calcium sulphate is left as a dense hard crust when the water evaporates. Magnesium and calcium carbonate may be in great part removed by treating the water in a large settling tank by Clark's process, which consists in adding milk of lime (quicklime mixed with water) in sufficient quantity to almost produce alkalinity. This curious reaction, by which lime is removed by adding lime, depends on the fact that calcium carbonate is held in solution by an excess of carbonic acid in the water. If this carbonic acid is converted to calcium carbonate, then all the calcium carbonate is precipitated and after allowing to stand for some time the purified water may be drawn off. The amount of lime to be added may be calculated or determined by experiment.

Mineral Waters. Although all natural waters contain mineral matter, the term mineral water is only applied to that which contains some rare substance or a large quantity of common ingredients. It is impossible to give any general rule for the interpretation of the analysis of mineral water and a discussion of the subject is apart from the object of this bulletin. Any competent physician can give the therapeutic action of the salts contained and can decide from the analysis what would be the probable effect of the

on the human system, but the action of such complex mixtures is so dependent on slight variations in the amount and character of the ingredients and on their relative proportions that it is only by years of experience that their medicinal value can be satisfactorily ascertained. It is probable that the reputation of some of the famous mineral waters is based more on extensive advertising and on the suggestion of the patients than on the composition of the water, and it is certain that attractive hotels and skillful physicians account for a large part of the popularity of a health resort. It sometimes happens in Wyoming that we find a man denouncing the "alkali water" of the State while to escape its deleterious effects he imports for his table use European water which contains a much greater quantity of the same salts.

IRRIGATION WATER.

Watering by irrigation is quite different from watering by rain in its effect upon the quantity and position of the soluble salts in the soil. In humid regions the pure rain water passes largely through the soil and drains off, carrying with it part of the soluble salts. In the arid region, where the drainage is slight and the evaporation greater, water containing mineral salts is applied to the ground and the water evaporates leaving the salts. Thus in the first case pure water is given to the soil and water containing mineral salts withdrawn below, while in the second case water containing mineral salts is given to the soil and pure water withdrawn from the surface. The effect in the first case is to decrease and in the second to increase the amount of soluble salts. In the arid region, therefore, the soluble

mineral matter will continually increase until in time proportion becomes so great as to interfere with agriculture.

ALKALI.

The word alkali is applied to those soluble salts of alkali metals and alkaline earths which accumulate on surface of the ground in the arid regions, often to such extent as to be injurious to vegetation. Although the term is not strictly accurate from a chemical standpoint, yet it is more nearly exact in its meaning than most scientific words in common use, and there seems to be no reason why it should be debarred from good usage by keeping it in quotation marks. The composition of alkali varies greatly but it is chiefly composed of the chlorids, sulphates, and carbonates of sodium and potassium, and sulphate of magnesium. Sulphate of lime is also generally present but as it is comparatively insoluble and is not injurious to vegetation it is not properly included in the term alkali. The potassium salts and the nitrates and phosphates sometimes found with alkali are plant foods and therefore beneficial. Of the sodium salts which form the principal part of most alkali the carbonate is the most injurious, and spots where it prevails are often black with decomposed vegetable matter, the account of which it is generally called "black alkali." The black alkali can be converted into the comparatively harmless sodium sulphate by treating the land with calcium sulphate (gypsum) as has been shown by the California Agricultural Experiment Station. With the exception of several large deposits, as in Natrona County, sodium carbonate does not occur in Wyoming to any great extent. Only two or three

ities on river bottoms where black alkali occurs have reported to this Station.*

On the other hand sodium sulphate is present in almost Wyoming soils and waters to a remarkable extent and in many places large areas are covered with a thick white coating of almost pure sodium sulphate, and deposits of several feet in thickness occur in the beds of dried-up streams.†

The injurious effects of alkali are not due so much to the excessive quantity of soluble salts in the soil as to the fact that the water charged with them is continually being evaporated to the surface, where it evaporates leaving a crust of alkali. Frequent cultivation checks this action by lessening evaporation and the soil can be cleared of its alkali by thorough drainage.

Since where the drainage is slight the salts in the irrigation water are almost all deposited in the soil, a knowledge of the composition of irrigation water is of great importance in deciding whether it is suitable for the purpose. Considerable areas of fertile land in the arid region have become alkali deserts in a few years by irrigating with water

* Wyoming Agricultural Experiment Station has been engaged several years in a study of the effects of alkali in the soil and the best methods for eliminating, and we will be glad to get reports from all parts of the State as to the amount and kind of injury done to vegetation. Samples of alkali sent to the Station will be analyzed qualitatively and a charge and advice given as to its treatment. For such an examination a few ounces scraped from the top of the soil is sufficient.

† The relative abundance of these two salts is quite in accordance with Prof. Hilgard's theory of the origin of sodium carbonate in the soil. U. S. Dept. of Agriculture, Weather Bureau, Bulletin No. 3. The Relation of Soil to Climate.

containing injurious salts. It is not wise to invest money in extensive irrigating systems before finding out whether the water supply is suitable for the purpose. All irrigated waters contain the alkali salts, but in some the amount is small and the character of the salts so innocuous that there is no practical risk of their ever causing an excess of alkali.

INTERPRETATION OF ANALYSES OF IRRIGATION WATER

In judging the suitability of a sample of water for irrigating purposes, the classification of salts given on page 103 may be used. The easily soluble salts of this list constitute the alkali and in the analyses of irrigation water the sum of these is reported separately. It must be remembered, however, that these salts are not all harmful. On the contrary, the potassium salts are very valuable and unfortunately are never added by irrigating in sufficient amount to compensate for that taken up by the crops and removed in harvesting. Sodium chlorid and magnesium salts rarely make trouble, while sodium carbonate is more injurious than sodium sulphate.

METHOD OF ANALYSIS.

The size of the sample of water obtained for analysis varied from 50 cc. to 50 liters, consequently the methods and completeness of the analyses are not the same. The samples collected outside Laramie were two to eight liters. The methods given by Prof. Gooch in his analysis of the waters of Yellowstone Park* were followed more closely than any other, particularly in the determination of lith

*U. S. Geological Survey, Bulletin No. 47.

carbonic acid. The residue from evaporation was always examined with the spectroscope for rare metals. Silica was almost always found unless the sample of water was very small. Where carbonic acid was actually determined it is noted as determined (det.); in all cases where it was merely calculated to satisfy the bases it is marked (cal.). The total solids were roughly checked by evaporation to dryness, and the bases were more exactly verified by converting into sulphates; determination being made in all cases when there was a discrepancy or when an unusual result was obtained. Silica was always treated with hydrofluoric acid when present in any considerable amount. In determining to form salts the bases were taken in the order, K, Na, Mg, Ca, and the acids, Cl, SO_3 , CO_2 .

ANALYSIS OF IRRIGATION WATERS.

LARAMIE EXPERIMENT FARM.

The Laramie Experiment Farm is irrigated from the North Platte River Canal, which obtains its water from the Laramie River about twenty miles above the farm. To ascertain the probable future effect of irrigating with this water on the composition of the soil it was necessary to analyze and determine both the water which ran on the land and that which ran off. For this purpose entering and waste weirs* and self-registering apparatus were put in and records were kept of the flow of water on each plat of ground during the season.

Samples of water were taken for analysis on three occasions, the summer of 1894 and spring and fall of 1895. As the crops, the land and the way of irrigating were all different it is thought the general results of these will apply to ordinary cases.

*Bulletin No. 8, Wyo. Ag. Exp. Sta. Irrigation and the Duty of

IRRIGATION OF JULY 19, 1894.

One and one-tenth acres of mixed crops, chiefly flax, barley and cow-pea, were irrigated by flooding. The records of the weirs were as follows:*

Entering Weir—

1½ hours, .2 foot .4515 cu. ft. per sec. = 2438.

3¾ hours, .22 foot = .5215 cu. ft. per sec. = 7040.

2½ hours, .23 foot = .5592 cu. ft. per sec. = 5032.

14511.

Water ran on, pounds per acre, 814,944.

Waste Weir—

4 hours, .0715 cu. ft. per second = 1029.6 cubic feet.

Water ran off, pounds per acre, 57,822.

ANALYSIS OF WATER.

	Irrigating Water		Waste Water		Solids Deposited
	Gr'ms per Liter	Pounds per Acre	Gr'ms per Liter	Pounds per Acre	Pounds per Acre
Insoluble Matter	.1779	145.0	.3449	19.9	125.5
Silica, SiO ₂	.1005	81.9	.0873	5.0	76.0
Iron & Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0017	1.4	.0021	.1	1.1
Potash, K ₂ O	.0023	1.9	.0062	.3	1.0
Soda, Na ₂ O	.0342	27.9	.0745	4.4	23.5
Lime, CaO	.0362	29.5	.0728	4.3	25.0
Magnesia, MgO	.0022	1.8	.0010	—	1.0
Hydrochloric acid, Cl	.0055	4.5	.0278	1.6	2.0
Sulphuric acid, SO ₃	.0117	9.5	.1033	6.0	3.0
Carbonic acid, CO ₂ (calc.)	.0448	36.4	.0402	2.3	34.0
(Less O equiv. of Cl)	(.0012)	(.9)	(.0062)	(.3)	(.3)
Total Solids	.4158	338.8	.7539	43.6	295.5

*All of the irrigation data were furnished by Prof. B. C. Buffum, Agriculturist of the Station.

ANALYSIS CALCULATED AS SALTS.

	Irrigation Water	Waste Water	Salts Deposited
	Grains per Liter	Grains per Liter	Pounds per Acre
SiO ₂	.1005	.0873	
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0017	.0021	
um chlorid, KCl	.0037	.0097	2.5
chlorid, NaCl	.0061	.0381	2.7
sulphate, Na ₂ SO ₄	.0208	.1249	6.2
ium sulphate, MgSO ₄	—	.0030	—
carbonate, Na ₂ CO ₃	.0377	—	33.3
n carbonate, CaCO ₃	.0628	.0912	45.0
n sulphate, CaSO ₄	—	.0527	—
ium carbonate, MgCO ₃	.0046	—	4.2
le Matter	.1779	.3449	—
Total Solids	.4158	.7539	93.9

IRRIGATION OF MAY 24-25, 1895.

First irrigation of potatoes. Amount of land irrigated 544 square feet. Water running on land May 24, 6 15 minutes; May 25, 7 hours, 35 minutes. Total amount of water used, 8,897.8 cubic feet or 624,000 pounds per acre. No waste water ran off.

ANALYSIS OF IRRIGATION WATER.

	Grams per Liter	Pounds per Acre
le Matter	.3472	216.6
SiO ₂	.0512	31.9
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0078	4.9
, K ₂ O	.0023	1.4
Na ₂ O	.0163	10.2
CaO	.0478	29.8
sia, MgO	.0105	6.5
chloric acid, Cl	.0018	1.1
ric acid, SO ₃	.0210	13.2
ic acid, CO ₂ (calc.)	.0515	32.1
as O equiv. of Cl)	(.0004)	(.2)
Total Solids	.5570	347.5

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Pounds per Acre
Silica, SiO_2	.0512	
Insoluble Matter	.3472	
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0078	
Potassium chlorid, KCl	.0037	1.2
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.0373	23.3
Magnesium carbonate, MgCO_3	.0245	15.3
Calcium carbonate, CaCO_3	.0853	53.2
Total Solids	.5570	93.0

IRRIGATION OF OCTOBER 2, 1895.

Furrow irrigation of rutabagas, 26,000 square feet
 Plat No. 10. Total irrigation for season as follows:

First Irrigation	July 6.	Water used,	11,791.08	cubic feet
"	"	"	"	"
"	"	"	8.	"
"	"	"	"	"
Second	"	Sept. 7.	"	"
"	"	"	"	"
Third	"	Oct. 2.	"	"
"	"	"	"	"
"	"	"	2.	"
"	"	Waste water,	425.07	"

Total water remaining on land, 39,725.25 " "

There was no waste water on first two irrigations.
 Samples for analysis were taken from the third irrigation.

Oct. 2. Pounds of water per acre ran on - 1,022,860
 " " " " " " " ran off - 26,520

ANALYSIS OF WATER.

	Irrigating Water		Waste Water		Solids Deposited
	Gr'ms per Liter	Pounds per Acre	Gr'ms per Liter	Pounds per Acre	Pounds per Acre
ble Matter	—	—	.4103	10.9	10.9
SiO ₂	.0505	51.7	.0125	.3	51.4
Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0049	5.0	.0077	.2	4.8
, K ₂ O	.0020	2.0	.0186	.5	1.5
Na ₂ O	.0124	12.7	.0438	1.2	11.5
sia, MgO	.0121	12.4	.0336	.9	11.5
CaO	.0393	40.2	.0667	1.7	38.5
chloric acid, Cl	.0125	12.8	.0167	.4	12.4
aric acid, SO ₃	.0264	27.0	.1239	3.3	23.7
nic acid, CO ₂ (calc.)	.0320	32.7	.0485	1.3	31.4
s O equiv. of Cl)	(.0028)	(2.9)	(.0037)	(.1)	(2.8)
Total Solids	.1893	193.6	.7786	20.6	173.0

ANALYSIS CALCULATED AS SALTS.

	Irrigation Water	Waste Water	Salts Deposited
	Grams per Liter	Grams per Liter	Pounds per Acre
ble Matter	—	.4103	
SiO ₂	.0505	.0125	
nd Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0049	.0077	
ium chlorid, KCl	.0032	.0294	2.4
m chlorid, NaCl	.0178	.0047	18.3
m sulphate, Na ₂ SO ₄	.0069	.0945	4.1
esium sulphate, MgSO ₄	.0338	.1008	32.1
esium carbonate, MgCO ₃	.0019	—	1.9
m sulphate, CaSO ₄	—	.0085	—
m carbonate, CaCO ₃	.0703	.1102	68.9
Total Solids	.1893	.7786	127.7

The average of the three analyses, including as they samples taken in three different seasons, gives a fair approximation to the average composition of Laramie irrigation water. The average amount of water used on the land the seasons of 1891 and 1892 on mixed crops was

68,185 cubic feet per acre. The records for 1893-4-5 are not yet worked up, but the general average will be about the same. This is supplemented by an average rain-fall of about twelve inches. The laws of the State of Wyoming allow a duty of one cubic foot per second for seventy acres, an amount which our experience shows is more than twice what is needed at Laramie. The following table gives the average composition of the Laramie water and also the amount of mineral matter deposited annually by 68,185 cubic feet per acre.

AVERAGE COMPOSITION OF LARAMIE IRRIGATION WATER.

	Grams per Liter	Pounds per Acre Deposited Annually
Insoluble Matter.....	.1750	744.6
Silica, SiO_2	.0674	286.8
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0048	20.4
Potash, K_2O	.0022	9.3
Soda, Na_2O	.0210	89.3
Lime, CaO	.0411	174.9
Magnesia, MgO	.0083	35.3
Hydrochloric acid, Cl	.0066	28.1
Sulphuric acid, SO_3	.0197	83.8
Carbonic acid, CO_2 (calc.).....	.0428	182.1
(Less O equiv. of Cl).....	(.0015)	(6.4)
Total Solids.....	.3874	1648.2
Alkali.....	.0571	24.0

Knowing the amount of mineral matter added to the soil by irrigating, it is of some interest to compare it with the amount taken away by harvesting the crops. The following table* gives the mineral matter taken from the soil

*As there are not sufficient ash analyses of American crops, the table is calculated from Lieke's *Praktische Duengetafeln*, published by the German Kali Co.

our common crops of average yield on the Wyoming experiment farms; wheat 30 bushels, potatoes 200 bushels, clover 25 tons, alfalfa 6 tons.

MINERAL CONSTITUENTS OF COMMON CROPS.

Crop.....	Alfalfa, pounds per Acre	Wheat, pounds per Acre	Potatoes, pounds per Acre	Turnips, pounds per Acre
Crop.....	12,000.0	1,800.0	12,000.0	50,000.0
H, K ₂ O	217.0	26.8	73.8	176.4
Na ₂ O	16.3	2.6	4.0	43.9
CaO	374.9	7.8	12.8	77.4
Magnesia, MgO.....	45.1	6.7	10.6	17.2
Fe ₂ O ₃	17.3	1.1	2.2	4.6
Phosphoric acid, P ₂ O ₅	78.2	20.6	21.6	54.2
Sulphuric acid, SO ₃	52.8	2.8	9.4	48.4
SiO ₂	87.8	95.3	36.0	11.1
Hydrochloric acid, Cl	27.9	1.9	5.2	29.8
Ammonia, N	345.6	50.9	46.7	124.2

RESULTS OF LARAMIE EXPERIMENTS IN IRRIGATION.

Some general conclusions may be drawn from the experiments, but it is questionable in how far they are applicable to other localities.

Waste water contains more salts than the irrigation water.

In the waste water the carbonates of the irrigation water are largely replaced by sulphates.

Waste water contains more potash in proportion to lime, and more magnesia in proportion to lime.

Irrigation by flooding, therefore, tends to increase the amount of soda and lime in the soil in comparison with the potash and magnesia, and the carbonates in comparison with the sulphates.

There is, however, no real decrease in the amount of any of the elements, at least where the waste water is not

more than a tenth of the irrigation water, so alkali is not washed out by ordinary flooding, as is commonly supposed.

Irrigation supplies to the soil more of all the elements than is taken away by cropping, except potash and phosphoric acid.

The amount and composition of the underground drainage water were not taken into consideration in these experiments, as nothing was known of it. For analyses of the soils of all the experiment farms, see Bulletin No. 6 of this Station.

WHEATLAND EXPERIMENT FARM.

The irrigation water of the Wheatland Experiment Farm is obtained from the Laramie River about seventy miles below the supply for the Laramie Experiment Farm. As will be seen by comparing the two analyses, the water has taken into solution a much larger amount of salts and the proportion of sulphates is greater. In calculating the amount of mineral matter deposited during the season it is assumed that the same quantity of water is used as at Laramie, 68,185 cubic feet per acre.

ANALYSIS OF WHEATLAND IRRIGATION WATER.

	Grams per Liter	Pounds per Acre Deposited Annually
Silica, SiO_2	.0195	83.0
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0048	20.4
Potash, $\text{K}_2 \text{O}$	.0102	43.4
Soda, $\text{Na}_2 \text{O}$	.0509	216.6
Lime, CaO	.0905	385.1
Magnesia, MgO	.0365	155.3
Hydrochloric acid, Cl	.0260	110.6
Sulphuric acid, SO_3	.1348	573.6
Carbonic acid, CO_2 (det.)	.0900	382.9
(Less O equiv. of Cl)	(.0058)	(24.7)
Total Solids	4574	1,946.2

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Pounds per Acre Deposited Annually
SiO ₂	.0195	83.0
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0048	20.4
Potassium chlorid, KCl	.0161	68.5
Sodium chlorid, NaCl	.0320	136.2
Sodium sulphate, Na ₂ SO ₄	.0777	330.6
Magnesium sulphate, MgSO ₄	.1095	465.9
Calcium sulphate, CaSO ₄	.0291	123.8
Calcium carbonate, CaCO ₃	.1400	595.7
Carbonic acid (free and in bicarbonates)	.0287	122.1
Total Solids	.4574	1,946.2
Alkali	.2353	1,001.2

SHERIDAN IRRIGATION WATER.

The Sheridan Experiment Farm is supplied with water from Little Goose Creek. The sample was taken Sept. 15, 1903. The analysis shows it to be more heavily charged with alkali than the water of any other of the Experiment Farms. If 68,185 cubic feet per acre are used during the season there will be deposited about a half ton of alkali on each acre. The drainage of this farm is poor and, although it has been cultivated only five years, the lower part of the farm is already rendered useless by accumulation of alkali.

ANALYSIS OF WATER.

	Grams per Liter	Pounds per Acre Deposited Annually
Silica, SiO_2	.0215	91.5
Lithia, Li_2O	Trace	—
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0033	14.0
Potash, K_2O	.0162	68.9
Soda, Na_2O	.0607	258.3
Lime, CaO	.0741	315.3
Magnesia, MgO	.0482	205.1
Hydrochloric acid, Cl	.0278	118.3
Sulphuric acid, SO_3	.1372	583.8
Carbonic acid, CO_2 (det.)	.1370	582.9
(Less O equiv. of Cl)	(.0063)	(26.5)
Total Solids	.5197	2,211.3

CALCULATED AS SALTS.

	Grams per Liter	Pounds per Acre Deposited Annually
Silica, SiO_2	.0215	91.5
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0033	14.0
Potassium chlorid, KCl	.0259	110.2
Sodium chlorid, NaCl	.0255	108.5
Sodium sulphate, Na_2SO_4	.1080	459.5
Magnesium sulphate, MgSO_4	.1145	487.7
Magnesium carbonate, MgCO_3	.0210	89.4
Calcium carbonate, CaCO_3	.1322	562.5
Carbonic acid, CO_2 (free and in bicarbonates)	.0678	—
Total Solids	.5197	1,922.8
Alkali	.2739	1,165.4

LANDER IRRIGATION WATER.

The Lander Experiment Farm is supplied with water from the Popo Agie. As will be seen from the analysis, it is the best water for irrigation that has been analyzed by this Station. In calculating the amount of mineral matter deposited on the land during the season the same amount of water, 68,185 cubic feet, is assumed to have been used as in the other cases.

ANALYSIS OF WATER.

	Grams per Liter	Pounds per Acre Deposited Annually
Silica, SiO_2	.0090	38.3
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0007	3.0
Potash, $\text{K}_2 \text{O}$	.0078	33.2
Soda, $\text{Na}_2 \text{O}$	.0279	118.7
Magnesia, MgO	.0054	23.0
Slime, CaO	.0143	60.8
Hydrochloric acid, Cl	.0111	47.2
Sulphuric acid, SO_3	.0052	22.1
Carbonic acid, CO_2 (det.)	.0324	137.9
Free CO_2 equiv. of Cl	(.0025)	(10.6)
Total Solids	.1113	473.6

CALCULATED AS SALTS.

	Grams per Liter	Pounds per Acre Deposited Annually
Silica, SiO_2	.0090	38.3
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0007	3.0
Potassium chlorid, KCl	.0123	52.3
Sodium chlorid, NaCl	.0086	36.6
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.0092	39.2
Sodium carbonate, $\text{Na}_2 \text{CO}_3$	.0341	145.1
Magnesium carbonate, MgCO_3	.0113	48.1
Calcium carbonate, CaCO_3	.0255	108.5
Carbonic acid, CO_2 (free and in bicarbonates)	.0006	2.5
Total Solids	.1113	473.6
Calcium chloride	.0642	273.2

ANALYSES OF WELL AND SPRING WATERS

SPRING NEAR SHEEP MOUNTAIN.

A sample of water from Ernest Davis' ranch near Sheep Mountain. Water is reported diuretic, but there is nothing in the analysis to account for the supposed physiological action. The sample was clear, tasteless, colorless, odorless, with a slight deposit of iron sulphid. It contained no lithia, chlorids or nitrates. It is one of the purest waters analyzed.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0072	.420
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0015	.087
Potash, $\text{K}_2 \text{O}$	.0014	.082
Soda, $\text{Na}_2 \text{O}$	.0085	.496
Lime, CaO	.0432	2.519
Magnesia, MgO	.0094	.548
Sulphuric acid, SO_3	.0106	.618
Carbonic acid, CO_2 (det)	.0608	3.546
Total Solids	.1426	8.316

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0072	.420
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0015	.087
Potassium sulphate, $\text{K}_2 \text{SO}_4$	.0026	.152
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.0167	.974
Sodium carbonate, $\text{Na}_2 \text{CO}_3$	.0020	.117
Magnesium carbonate, MgCO_3	.0197	1.149
Calcium carbonate, CaCO_3	.0771	4.499
Carbonic acid, CO_2 (free and in bicarbonates)	.0158	.921
Total Solids	.1426	8.316

PELTON ARTESIAN WELL.

This well is on the ranch of Mr. Clark W. Pelton in northwest quarter of section 10, township 15, range 73, in Albany County. It is 333 feet deep and water struck at 120 feet. Temperature of the water is 47 degrees Fahr.

The water is strongly impregnated with hydrogen acid, H_2S . Chlorids are absent.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0257	1.499
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0014	.082
Sodium, K ₂ O	.0102	.595
Na ₂ O	.0196	1.143
CaO	.2660	15.512
Magnesia, MgO	.1060	6.181
Sulphuric acid, SO ₃	.4380	25.542
Carbonic acid, CO ₂ (calc.)	.1032	6.018
Total Solids	.9701	56.572

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0257	1.499
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0014	.082
Sodium sulphate, K ₂ SO ₄	.0188	1.096
Sodium Sulphate, Na ₂ SO ₄	.0448	2.612
Magnesium sulphate, MgSO ₄	.3180	18.544
Calcium sulphate, CaSO ₄	.3269	19.063
Calcium carbonate, CaCO ₃	.2345	13.676
Total Solids	.9701	56.572

RAWLINS ARTESIAN WELL NO. I.

This sample was sent Nov. 24, 1893, by Mayor R. Mussen. The well is 467 feet deep and flows 108,000 gallons in twenty-four hours. For description of this and other artesian wells in southern Wyoming, see Bulletin No. 20 of this Station, by Dr. J. D. Conley.

ANALYSIS OF WATER.

	Grams per Liter	Grains Gallon
Silica, SiO_2	.0116	.676
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0011	.064
Lithia, $\text{Li}_2 \text{O}$	Trace	Trace
Potash, $\text{K}_2 \text{O}$	.0095	.554
Soda, $\text{Na}_2 \text{O}$	.1880	10.964
Lime, CaO	.1707	9.955
Magnesia, MgO	.0435	2.537
Hydrochloric acid, Cl	.2255	13.150
Sulphuric acid, SO_3	.3226	18.812
Carbonic acid, CO_2 (calc.)	.0020	.116
(Less O equiv. of Cl)	(.0509)	(2.968)
Total Solids	.9236	53.860

CALCULATED AS SALTS.

	Grams per Liter	Grains Gallon
Silica, SiO_2	.0116	.676
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0011	.064
Potassium chlorid, KCl	.0152	.886
Sodium chlorid, NaCl	.3540	20.644
Magnesium chlorid, MgCl_2	.0051	.298
Magnesium sulphate, MgSO_4	.1239	7.225
Calcium sulphate, CaSO_4	.4081	23.799
Calcium carbonate, CaCO_3	.0046	.268
Total Solids	.9236	53.860

RAWLINS ARTESIAN WELLS NOS. 1 AND 2.

The city of Rawlins is supplied with the combined of Well No. 1, of which analysis has just been given, Well No. 2, bored about 60 feet away and 486 feet . The total flow is 540,000 gallons a day; temperature egresses Fahr. The sample was sent by Mayor Ras- en, Feb. 28, 1894.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0105	.612
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0014	.082
h, K ₂ O	.0061	.356
Na ₂ O	.1871	10.912
CaO	.1345	7.843
esia, MgO	.0503	2.933
ochloric acid, Cl	.1720	10.030
uric acid, SO ₃	.2403	14.013
onic acid, CO ₂ (calc.)	.0578	3.371
ess O equiv. of Cl)	(.0387)	(2.257)
Total Solids	.8213	47.895

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0105	.612
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0014	.082
esium chlorid, KCl	.0096	.560
m chlorid, NaCl	.2761	16.101
m sulphate, Na ₂ SO ₄	.0935	5.453
esium sulphate, MgSO ₄	.1509	8.800
um sulphate, CaSO ₄	.1479	8.625
um carbonate, CaCO ₃	.1314	7.662
Total Solids	.8213	47.895

SPRING WATER NEAR RAWLINS.

A sample of water from spring on ranch two miles northeast of Rawlins, furnished May 1, 1893, by State Examiner Henderson. The spring comes from limestone formation on the level prairie. The flow is large, filling twelve-inch pipe. The water is cold and has strong odor of hydrogen sulphid, the amount of which was not determined in sample sent, as some of it had escaped. Lithium and phosphoric acid are present in small amount.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0140	.816
Potash, K_2O	.0152	.886
Soda, Na_2O	.1745	10.176
Lime, CaO	.2073	12.089
Magnesia, MgO	.1042	6.077
Hydrochloric acid, Cl	.1382	8.059
Sulphuric acid, SO_3	.4855	28.313
Carbonic acid, CO_2 (det.)	.1970	11.488
(Less O equiv. of Cl)	(.0311)	(1.814)
Total Solids	1.3048	76.090

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0140	.816
Potassium chlorid, KCl	.0241	1.405
Sodium chlorid, NaCl	.2088	12.176
Sodium sulphate, Na_2SO_4	.1464	8.537
Magnesium sulphate, MgSO_4	.3127	18.236
Calcium sulphate, CaSO_4	.3306	19.280
Calcium carbonate, CaCO_3	.1271	7.412
Carbonic acid, CO_2 (free and in bicarbonates)	.1411	8.228
Total Solids	1.3048	76.090

LARAMIE CITY SPRINGS.

Laramie is supplied with water from springs 2 miles and 114 feet higher than the city. The springs are in limestone formation and flow is 3,000,000 gallons in 24 h. The analysis shows that the water contains little iron, but is quite hard. The hardness can be almost all removed by boiling or adding lime water.

The residue from fifteen liters showed no hydrobromic, hydroiodic or boric acid, no heavy metals and no rare elements except lithium.

ORGANIC ANALYSIS.

A few tests have been made from time to time on Laramie water to determine the amount and source of organic contamination. It will be seen that the water as it comes from the ground is of great purity, but that it accumulates, in its course to the city, a dangerous amount of decomposing vegetable or animal matter. There is no definite safety limit for organic impurity, but more than .10 parts per million is usually regarded as poor water and more than .15 as unsafe. Of course, in this case the greatest danger is from impure water, that of contamination by sewage and consequent presence of specific disease germs, is absent. Analyses of the county and University artesian waters are made for comparison.

Date	Source.	Free Ammonia, parts per Million	Albumin Ammonia, parts per Million
Apr. 18, 1893	Mouth of spring.....	.000	.046
Apr. 18, 1893	Pond, mouth of city pipe	.126	.100
Apr. 18, 1893	Stone reservoir	.013	.100
Apr. 17, 1893	In the city.....	.040	.114
Apr. 19, 1893	In the city.....	.044	.104
Apr. 24, 1893	In the city.....	.032	.088
Oct. 2, 1892	In the city.....	.003	.013
Apr. 18, 1893	County artesian well.....	.070	.020
Apr. 19, 1893	University artesian well.....	.002	.030

ANALYSIS OF LARAMIE CITY WATER.

Sample taken Aug. 31, 1892.	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0087	.507
Iron & Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0040	.233
Lithia, $\text{Li}_2 \text{O}$	Trace	Trace
Potash, $\text{K}_2 \text{O}$	.0012	.078
Soda, $\text{Na}_2 \text{O}$	.0047	.274
Lime, CaO	.0668	3.896
Magnesia, MgO	.0260	1.517
Hydrochloric acid, Cl	.0042	.243
Sulphuric acid, SO_3	.0053	.306
Carbonic acid, CO_2 (det)	.1474	8.596
(Less O equiv. of Cl)	(.0010)	(.058)
Total Solids	.2673	15.587

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0087	.507
Iron and Alumina $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0040	.233
Potassium chlorid, KCl	.0019	.111
Sodium chlorid, NaCl	.0054	.315
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.0040	.233
Magnesium sulphate, MgSO_4	.0047	.274
Magnesium carbonate, MgCO_3	.0512	2.986
Calcium carbonate, CaCO_3	.1192	6.951
Carbonic acid (free and in bicarbonates)	.0682	3.977
Total Solids	.2673	15.587

UNIVERSITY ARTESIAN WELL.

The artesian well on the University campus is 1,015 feet deep and flows 50,000 gallons in twenty-four hours. The water comes from two veins, one at 358 feet and the other at 820 feet. It is of much the same composition as the water of the city springs, but contains more alkali salts, especially sodium chlorid.

The residue from six liters showed no rare metals, except lithium, with the spectroscope, and gave no reactions for bromids, iodids or borates. The residue from thirty liters showed no barium or strontium and gave no reactions for arsenic, tin, lead, copper or manganese.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0163	.950
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0008	.047
Lime, Li ₂ O	Trace	Trace
Soda, K ₂ O	.0023	.134
Soda, Na ₂ O	.0133	.776
Calcium, CaO	.0643	3.749
Magnesia, MgO	.0361	2.105
Hydrochloric acid, Cl	.0137	.799
Sulphuric acid, SO ₃	.0129	.752
Carbonic acid, CO ₂ (det.)	.1326	7.733
Chlorine equiv. of Cl)	(.0031)	(.180)
Total Solids	.2892	16.865

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0163	.950
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0008	.047
Sodium chlorid, KCl	.0036	.210
Sodium chlorid, NaCl	.0198	1.155
Sodium sulphate, Na ₂ SO ₄	.0064	.373
Calcium sulphate, Mg ₂ SO ₄	.0139	.810
Calcium carbonate, Mg ₂ CO ₃	.0661	3.855
Calcium carbonate, CaCO ₃	.1148	6.695
Carbonic acid, CO ₂ (free and in bicarbonates)	.0475	2.770
Total Solids	.2892	16.865

NEW ARTESIAN WELL AT FILLMORE.

A sample of water from the new artesian well at Fillmore, at depth of 995 feet. The flow is very small. Secured May 6, 1895, by Wm. Niland, Div. Foreman, Rawlins. Water turbid, analyzed unfiltered.

ANALYSIS OF WATER.

	Grams per Liter	Grains Gallon
Silica, SiO_2	.0989	5.767
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0107	.624
Potash, K_2O	.0142	.828
Soda, Na_2O	.5550	32.365
Lime, CaO	.0225	1.312
Magnesia, MgO	.0070	.408
Hydrochloric acid, Cl	.0108	.631
Sulphuric acid, SO_3	.1388	8.094
Carbonic acid, CO_2 (calc.)	.3455	20.148
(Less O equiv. of Cl)	(.0024)	(.140)
Total Solids	1.2010	70.037

CALCULATED AS SALTS.

	Grams per Liter	Grains Gallon
Silica, SiO_2	.0989	5.767
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0107	.624
Potassium chlorid, KCl	.0226	1.318
Sodium sulphate, Na_2SO_4	.2422	14.124
Sodium carbonate, Na_2CO_3	.7717	45.003
Magnesium carbonate, MgCO_3	.0147	.857
Calcium carbonate, CaCO_3	.0402	2.344
Total Solids	1.2010	70.037

WELL ON SHERIDAN EXPERIMENT FARM.

This water contains too much mineral matter to be of use, either for irrigation or domestic purposes. Specific gravity 1.0030.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Ca, SiO ₂	.0151	.881
Alumina, Li ₂ O	Trace	Trace
Potash, K ₂ O	.0187	1.091
Soda, Na ₂ O	.2231	13.010
Magnesia, CaO	.5526	32.225
Magnesia, MgO	.4228	24.656
Hydrochloric acid, Cl	.0167	.974
Sulphuric acid, SO ₃	1.8127	105.709
Carbonic acid, CO ₂ (det.)	.0940	5.482
Less O equiv. of Cl)	(.0037)	(.216)
Total Solids	3.1520	183.812

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Ca, SiO ₂	.0151	.881
Potassium chlorid, KCl	.0296	1.726
Sodium chlorid, NaCl	.0043	.251
Sodium sulphate, Na ₂ SO ₄	.5052	29.461
Magnesium sulphate, MgSO ₄	1.2684	73.968
Calcium sulphate, CaSO ₄	1.1605	67.676
Calcium carbonate, CaCO ₃	.1336	7.791
Carbonic acid, CO ₂ (free and in bicarbonates)	.0353	2.058
Total Solids	3.1520	183.812

SARATOGA MINERAL SPRINGS.

Sample from Cadwell's Hot Spring sent by J. F. Crawford, Editor Saratoga Sun, April 20, 1894. The chief constituents are sodium chlorid (common salt) and sodium sulphate (Glauber's salt).

The Saratoga mineral waters have been used for many years as therapeutic agents.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.1264	7.371
Iron & Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0030	.174
Lithia, $\text{Li}_2 \text{O}$	Trace	Trace
Potash, $\text{K}_2 \text{O}$	.0261	1.522
Soda, $\text{Na}_2 \text{O}$	.6601	38.495
Lime, CaO	.1527	8.905
Magnesia, MgO	.0071	.414
Hydrochloric acid, Cl	.5417	31.590
Sulphuric acid, SO_3	.3949	23.029
Carbonic acid, CO_2 (calc.)	.0545	3.178
(Less O equiv. of Cl)	(.1219)	(7.109)
Total Solids	1.8446	107.569

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.1264	7.371
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0030	.174
Potassium chlorid, KCl	.0414	2.414
Sodium chlorid, NaCl	.8613	50.228
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.4650	27.117
Magnesium sulphate, MgSO_4	.0213	1.242
Calcium sulphate, CaSO_4	.2023	11.797
Calcium carbonate, CaCO_3	.1239	7.226
Total Solids	1.8446	107.569

SARATOGA MINERAL SPRINGS.

Sample from Pilson Flowing Well sent by Mr. J. F. Ford, Editor Saratoga Sun, April 20, 1894. This is not cased up properly, so the sample contains some very cold water. In spite of this the analysis is substantially the same as the preceding, and doubtless the water from the two springs is really identical in composi-

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0602	3.511
Al ₂ O ₃ , K ₂ O*	.0225	1.312
Na ₂ O	.6297	36.721
CaO	.1728	10.077
Magnesia, MgO	.0181	1.056
Hydrochloric acid, Cl	.5500	32.074
Sulphuric acid, SO ₃	.4462	26.070
Carbonic acid, CO ₂ (calc.)	.0258	1.504
Loss O equiv. of Cl)	(.1237)	(7.213)
Total Solids	1.8016	105.062

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0602	3.511
Potassium chlorid, KCl	.0358	2.088
Sodium chlorid, NaCl	.8793	51.277
Sodium sulphate, Na ₂ SO ₄	.3735	21.781
Magnesium sulphate, MgSO ₄	.0543	3.167
Calcium sulphate, CaSO ₄	.3399	19.821
Calcium carbonate, CaCO ₃	.0586	3.417
Total Solids	1.8016	105.062

* The potassium determination was lost. It is supplied by assumption that sodium and potassium are in the same ratio as in the preceding analysis.

THERMOPOLIS MINERAL SPRINGS. •

A sample of water from the Main Spring, obtained Nov. 23, 1894, by Mr. J. A. McAvoy, from Mr. Joseph Magill. The temperature of the water is 136 degrees Fahr., and it is reported to contain hydrogen sulphid, but this had escaped from sample when received. Specific gravity, 1.0015. A partial analysis obtained by Dr. J. Schuelke from the College of France gives 2.1495 grams per liter of total solids. There are two other springs a little north of the large spring, which are cooler and apparently different in composition.

The Thermopolis mineral waters are reported to be of great value for rheumatic complaints and for diseases of the kidneys, stomach and liver. They are used both internally and externally.

ANALYSIS OF WATER.

	Grams per Liter	Grains Gallon
Silica, SiO_2	.0855	4.98
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0039	.22
Lithia, $\text{Li}_2 \text{O}$	Trace	Trace
Potash, $\text{K}_2 \text{O}$	.1109	6.46
Soda, $\text{Na}_2 \text{O}$	.3515	20.49
Lime, CaO	.4813	28.06
Magnesia, MgO	.1111	6.47
Hydrochloric acid, Cl	.3558	20.74
Sulphuric acid, SO_3	.5008	29.20
Carbonic acid, CO_2 (calc.)	.3052	17.79
(Less O equiv. of Cl)	(.0800)	(4.66)
Total Solids	2.2260	129.81

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
a, SiO_2	.0855	4.986
and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0039	.227
ssium chlorid, KCl	.1756	10.240
um chlorid, NaCl	.4492	26.195
um sulphate, $\text{Na}_2 \text{SO}_4$	.2591	15.110
nesium sulphate, MgSO_4	.3334	19.443
um sulphate, CaSO_4	.2256	13.156
um carbonate, CaCO_3	.6937	40.454
Total Solids	2.2260	129.811

WATER FROM MUSKRAT FORK OF POISON CREEK,
FREMONT COUNTY.

Sample taken July 31, 1894, by Prof. W. C. Knight.
Specific gravity 1.0023. It is a strong alkali water, containing chiefly sodium and magnesium sulphates.

This and the two following samples developed a standing peculiar vegetable growths, which were sent Prof. W. G. Farlow of Harvard for identification. The sample contained *Beggiatoa alba*, which is noteworthy since sulphur is contained in the water only as sulphates.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0422	2.461
Potash, K_2O	.0213	1.242
Soda, Na_2O	.6306	36.774
Lime, CaO	.2426	14.147
Magnesia, MgO	.1057	6.164
Hydrochloric acid, Cl	.0445	2.595
Sulphuric acid, SO_3	1.1124	64.871
Carbonic acid, CO_2 (calc.)	.1243	7.249
(Less O equiv. of Cl)	(.0100)	(.583)
Total Solids	2.3136	134.920

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0422	2.461
Potassium chlorid, KCl	.0338	1.971
Sodium chlorid, NaCl	.0468	2.729
Sodium sulphate, Na_2SO_4	1.3864	80.845
Magnesium sulphate, MgSO_4	.3171	18.492
Calcium sulphate, CaSO_4	.2047	11.935
Calcium carbonate, CaCO_3	.2826	16.480
Total Solids	2.3136	134.920

WARM SULPHUR WATER FROM GUTHERY WELL,
NATRONA COUNTY.

Sample from an oil-well in Sec. 18, R. 82, T. 33, twenty-five miles west of Casper. Temperature 68 deg. Fahr.; reported charged with hydrogen sulphid, but there was none in sample when received. Reaction alkaline; specific gravity 1.0015. The organic growth was chiefly *Costoc Linchia* and *Scenedesmus quadricauda*.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0362	2.111
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0025	.146
Potash, $\text{K}_2 \text{O}$	.0061	.356
Soda, $\text{Na}_2 \text{O}$	.5618	32.762
Lime, CaO	.0054	.315
Magnesia, MgO	.0014	.082
Hydrochloric acid, Cl	.0111	.647
Sulphuric acid, SO_3	.4713	27.484
Carbonic acid, CO_2 (det.)	.1672	9.750
(Less O equiv. of Cl)	(.0025)	(.146)
Total Solids	1.2605	73.507

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0362	2.111
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0025	.146
Potassium chlorid, KCl	.0097	.566
Sodium chlorid, NaCl	.0107	.624
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.8369	48.804
Sodium carbonate, $\text{Na}_2 \text{CO}_3$	.3057	17.827
Magnesium carbonate, MgCO_3	.0029	.169
Calcium carbonate, CaCO_3	.0096	.560
Carbonic acid, CO_2 (free and in bicarbonates)	.0463	2.700
Total Solids	1.2605	73.507

WATER FROM ALKALI SPRINGS, FREMONT COUNTY.

Sample taken by Prof. W. C. Knight, July 31, 1894.
Specific gravity 1.0044; reaction alkaline. The sample developed on standing a filamentous blue-green alga, *Tolythrix terruis*.

This spring is located in Fremont County, Township 34, Range 95.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0570	3.324
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0019	.111
Potash, K_2O	.0205	1.195
Soda, Na_2O	2.3418	136.564
Lime, CaO	.0140	.816
Magnesia, MgO	.0151	.880
Hydrochloric acid, Cl	.8006	46.688
Sulphuric acid, SO_3	.0070	.408
Carbonic acid, CO_2 (det.)	1.8096	105.529
(Less O equiv. of Cl)	(.1801)	(10.502)
Total Solids	4.8874	285.013

CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
Silica, SiO_2	.0570	3.324
Iron and Alumina, Fe_2O_3 , Al_2O_3	.0019	.111
Potassium chlorid, KCl	.0325	1.895
Sodium chlorid, NaCl	1.2951	75.525
Sodium sulphate, Na_2SO_4	.0124	.723
Sodium carbonate, Na_2CO_3	2.8182	164.346
Magnesium carbonate, MgCO_3	.0317	1.848
Calcium carbonate, CaCO_3	.0250	1.458
Carbonic acid, CO_2 (free and in bicarbonates)	.6136	35.783
Total Solids	4.8874	285.013

ALCOVA HOT SPRINGS.

Samples taken from two springs by Prof. W. C. in April, 1894. Analysis showed the two were cal. The two springs are located in south-west er, Township 31, Range 82, and are about 100 feet The temperature of the water is 139 degrees Fahr.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0397	2.315
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0022	.128
Li ₂ O	Trace	Trace
, K ₂ O	.0159	.927
Na ₂ O	.2837	16.544
CaO	.2279	13.291
esia, MgO	.0990	5.773
chloric acid, Cl	.2970	17.320
ric acid, SO ₃	.3848	22.441
ic acid, CO ₂ (calc.)	.1002	5.843
s O equiv. of Cl)	(.0670)	(3.908)
Total Solids	1.3834	80.674

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0397	2.315
and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.0022	.128
um chlorid, KCl	.0251	1.464
n chlorid, NaCl	.4706	27.443
n sulphate, Na ₂ SO ₄	.0771	4.496
sium sulphate, MgSO ₄	.2971	17.326
n sulphate, CaSO ₄	.2438	14.217
n carbonate, CaCO ₃	.2278	13.285
Total Solids	1.3834	80.674

WARM SPRINGS, LARAMIE COUNTY.

Sample taken from the source of Warm Spring Cr.
two miles south of the Platte. Temperature of water
degrees Fahr.

ANALYSIS OF WATER.

	Grams per Liter	Grains Gall
Silica, SiO_2	.0385	2.2
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0057	.3
Potash, $\text{K}_2 \text{O}$	.0066	.3
Soda, $\text{Na}_2 \text{O}$	.0378	2.2
Lime, CaO	.0572	3.3
Magnesia, MgO	.0314	1.8
Hydrochloric acid, Cl	.0111	.6
Sulphuric acid, SO_3	.0735	4.2
Carbonic acid, CO_2 (det.)	.0872	5.0
(Less O equiv. of Cl)	(.0024)	(.1)
Total Solids	.3466	20.2

CALCULATED AS SALTS.

	Grams per Liter	Grains Gall
Silica, SiO_2	.0385	2.2
Iron and Alumina, $\text{Fe}_2 \text{O}_3$, $\text{Al}_2 \text{O}_3$	.0057	.3
Potassium chlorid, KCl	.0106	.6
Sodium chlorid, NaCl	.0099	.5
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	.0746	4.3
Magnesium sulphate, MgSO_4	.0473	2.7
Magnesium carbonate, MgCO_3	.0328	1.9
Calcium carbonate, CaCO_3	.1021	5.9
Carbonic acid, CO_2 (free and in bicarbonates)	.0251	1.4
Total Solids	.3466	20.2

SALT WATER FROM NEWCASTLE.

Sample sent by Hon. F. W. Mondell, Newcastle, Wyo.
This water resembles sea-water in composition, but is
about two-thirds as strong.

ANALYSIS OF WATER.

	Grams per Liter	Grains per Gallon
SiO ₂	.0352	2.052
Al ₂ O ₃	.033	1.930
Na ₂ O	8.1044	472.617
CaO	1.2226	71.297
Magnesia, MgO	.3082	17.973
Hydrochloric acid, Cl	9.3138	543.144
Sulphuric acid, SO ₃	2.0788	121.227
Carbonic acid, CO ₂ (calc.)	.1375	8.018
Loss O equiv. of Cl)	(2.1011)	(122.528)
Total Solids	19.1325	1,115.730

ANALYSIS CALCULATED AS SALTS.

	Grams per Liter	Grains per Gallon
SiO ₂	.0352	2.052
Sodium chlorid, KCl	.0524	3.056
Sodium chlorid, NaCl	15.2740	891.719
Magnesium chlorid, MgCl ₂	.0408	2.379
Magnesium sulphate, MgSO ₄	.8733	50.927
Calcium sulphate, CaSO ₄	2.5443	148.373
Calcium carbonate, CaCO ₃	.3125	18.224
Total Solids	19.1325	1,115.730

LARAMIE LITHIA WATER.

In April, 1895, while prospecting for coal, a mile and a half west of Laramie, Mr. Jacob Fein struck a vein of mineral water at a depth of 58 feet. The water is interesting on account of containing more lithia than any other analyzed from this State. Sample No. 1 was taken when the water was first found and Sample No. 2 some weeks later when a large amount had been pumped out. Another well about 1500 feet south of the first, gives water of similar composition, but containing about twice as much mineral matter. The lithia in this second well is .0048 grams per liter or as lithium chlorid is .799 grains per gallon. Sample No. 1 has a specific gravity of 1.0033.

	SAMPLE NO. 1.		SAMPLE NO. 2.	
	Grains per Liter	Grains per Gallon	Grains per Liter	Grains per Gallon
Silica, SiO_2	.0388	2.263	.0206	1.181
Iron and Alumina, $\text{Fe}_2 \text{O}_3, \text{Al}_2 \text{O}_3$	—	—	.0024	.136
Lithia, $\text{Li}_2 \text{O}$	.0041	.239	.0028	.156
Potash, $\text{K}_2 \text{O}$	.0176	1.026	.0112	.634
Soda, $\text{Na}_2 \text{O}$	.6471	37.736	.5503	32.24
Lime, CaO	.3280	19.128	.2039	11.81
Magnesia, MgO	.2896	16.888	.1596	9.44
Hydrochloric acid, Cl	.0834	4.863	.0834	4.863
Sulphuric acid, SO_3	1.7361	101.242	1.1810	68.81
Carbonic acid, CO_2 *	.0620	3.616	.0620	3.616
(Less O equiv. of Cl)	(.0188)	(1.096)	(.0188)	(1.096)
Total Solids	3.1879	185.905	2.2584	131.46
AS SALTS.				
Silica, SiO_2	.0388	2.263	.0206	1.181
Iron and Alumina $\text{Fe}_2 \text{O}_3, \text{Al}_2 \text{O}_3$	—	—	.0024	.136
Lithium chlorid, LiCl	.0118	.683	.0078	.456
Potassium chlorid, KCl	.0279	1.627	.0178	1.008
Sodium chlorid, NaCl	.0994	5.795	.1127	6.44
Sodium sulphate, $\text{Na}_2 \text{SO}_4$	1.3604	79.333	1.1225	65.56
Magnesium sulphate, MgSO_4	.8688	50.665	.4788	27.92
Calcium sulphate, CaSO_4	.6643	38.739	.3908	22.77
Calcium carbonate, CaCO_3	.0973	5.674	.0768	4.44
Carbonic acid CO_2 (free and in bicarbs)	.0192	1.120	.0282	1.632
Total Solids	3.1879	185.905	2.2584	131.46

* Determined in Sample No. 2 and assumed to be the same in Sample No. 1.

ANALYSES OF CELEBRATED MINERAL WATERS.

On this page are given analyses of several well-known mineral waters which may be compared with the analyses of Wyoming mineral waters. The analysis of the sea-water of the water from the Apollinaris spring in Heppingen, Prussia, are taken from Thorpe's Dictionary of Applied Chemistry. The analysis of the water from Vichy, France, is taken from the Encyclopædia Britannica. The analysis of the water from the Sprudel Spring, Carlsbad, Bohemia, is taken from Koenig's Nahrungsmittel. The analysis of the water from the Cleopatra Spring, Yellowstone National Park, from Bulletin No. 47, U. S. Geological Survey.

	Analyses stated in grams per liter.				
	VICHY	CARLS- BAD	APOL- LINARIS	CLE- OPATRA	SEA WATER
Sodium bicarbonate, NaHCO_3	4.883	1.475	1.352		
Potassium bicarbonate, KHCO_3	.352				
Magnesium bicarbonate, $\text{Mg}(\text{HCO}_3)_2$	.303		.575		
Calcium bicarbonate, $\text{Ca}(\text{HCO}_3)_2$	.434		.375		
Sodium sulphate, Na_2SO_4	.292	2.406	.213	.145	
Sodium chlorid, NaCl	.534	1.942	.377	.191	26.439
Carbonic acid, free, CO_2		.140		.354	
Potassium sulphate, K_2SO_4		.187			
Magnesium sulphate, MgSO_4		.729		.355	2.066
Magnesium chlorid, MgCl_2		.012			3.151
Calcium chlorid, CaCl_2		1.175			
Magnesium carbonate, MgCO_3		.166			
Calcium carbonate, CaCO_3		.322		.625	.047
Iron carbonate, FeCO_3		.003	.017		.005
Potassium chlorid, KCl				.098	.746
Magnesium bromid, MgBr_2					.070
Calcium sulphate, CaSO_4				.195	1.332
Lithium chlorid, LiCl				.014	
Silica, SiO_2			.013	.052	
Sodium borate, $\text{Na}_2\text{B}_4\text{O}_7$				.033	
Alumina, Al_2O_3				.009	
Sodium arsenite, NaAsO_2				.004	
Total Solids.....	6.798	7.707	2.922	2.085	33.856



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UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,

LARAMIE, WYOMING.

BULLETIN NO. 25.

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RESULTS OF THREE YEARS' EXPERIMENTS
IN COST AND PROFIT OF GROW-
ING WHEAT.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Ex-
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THE HORTICULTURIST IN CHARGE,					
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ST AND PROFIT OF GROWING WHEAT.

B. C. BUFFUM.

Excepting in two or three localities sufficient wheat is yet being grown in Wyoming to supply the home mar-

This is not due to any unfavorable conditions of soil climate, but may be attributed to lack of agricultural development. Three years ago the Experiment Station took the subject of wheat growing and instituted experiments carried out upon each of the Experiment Farms to determine the place this important product would occupy as a general farm crop in this State.

Naturally the first question in any farming operation is, should be, will it pay? Many have expressed the opinion that wheat would not pay in this State, as, owing to the expense of irrigation, we could not compete with such wheat-growing States as the Dakotas and Minnesota. This opinion, however, is fallacious, as there are several points of advantage in an irrigated crop, any one of which would give a return more than sufficient to meet the comparatively small expense attached to watering the land. The advantages of raising grain under irrigation may be summed up briefly as follows:

1.—With plenty of water for irrigation there never can be a failure of crop. The results of our experiments indicate that the failure of a wheat crop for a single season would entail a loss equivalent to the expense of irrigating the land for not less than ten years.

2.—Larger yields are obtained from irrigated farms. The Statistician's Report for 1890 gives the average yield of wheat in the United States for the preceding period of ten years as twelve bushels per acre. In no irrigated state was it as low as twelve bushels, Wyoming and Colorado being the highest with eighteen and nineteen and one-half bushels respectively. The value of the Wyoming crop was placed at \$14.87 per acre. But little land was cultivated in this State during the period covered by the report. I believe an average of eighteen bushels per acre too low at the present time. Since 1890 the acreage of wheat has been greatly increased. The census for 1890 gave the area in wheat as 4,538 acres. The State Engineer's Report for 1892 shows that Uinta County alone had as great an acreage and that the increase in Carbon and Converse Counties was from 56 acres and 6 acres respectively in 1890 to 1,000 acres in Carbon and 1,200 in Converse County in 1892. In the last five years wheat yields of less than twenty bushels per acre rarely have been obtained either upon the Station Farms or, so far as we have records, upon other farms in the State.

In our three years' experiments upon the different Experiment Farms, one of them being unirrigated, the average yield is 32.9 bushels per acre. (See Table IV.) An increase of two bushels per acre more than pays the cost of irrigation.

3.—Irrigated grain is heavier and of better quality than grain raised without irrigation. Some of our varieties

at the World's Fair weighed sixty-six pounds per bushel and sixty pound wheat is below the average. Such wheat is of greater value than a lighter and poorer product. To illustrate the difference in value between irrigated and non-irrigated grain, I may mention that at the present time in the Laramie market oats from irrigated districts are selling at twenty cents more per hundred pounds than oats from non-irrigated farms.

4.—Irrigation tends to keep up the fertility of the soil. This is especially true where the water contains sediment. I believe this item alone of sufficient value to overbalance the expense of irrigation.

COST OF RAISING WHEAT.

The cost will vary in different localities. It is influenced by the price of labor, the kind and condition of the machinery, the season, whether wet or dry, the extent to which improved machinery is used, and the manner in which the farmer plans and executes the work.

As has been stated,* the cost in North Dakota upon the best areas, unirrigated and with the use of improved machinery, has been reduced to \$4.50 and \$5.00 per acre. In Kansas† several years ago, the total average cost of raising wheat was placed at \$7.50 per acre. In Nebraska in 1904‡ the cost of raising wheat is shown to be from \$6.13 to \$10.32 per acre.

The results of our experiments given in Tables I, II and III, show a variation in the cost of producing an acre of wheat from \$7.30 to \$13.36, the average cost given in Table

*Wyo. Sta. Bul. No. 22. †Ark. Sta. Bul. No. 6. ‡Neb. Sta. Bul. No. 29.

IV being \$10.38. This is the actual cost upon single acres of land, the expense being computed from the actual time spent, at the local price for labor. The cost of threshing only has been estimated the same for each place at five cents per bushel. Generally the plats were harvested by hand, thus increasing the expense, and the cost of irrigation is greater in proportion than upon larger areas.

The present season the expense upon the Laramie Farm, with the use of improved machinery, would not have exceeded \$7.60 per acre, while the actual expense as given in the table was \$9.11. It may be safely stated that, where fields of forty acres or more are grown under average conditions, the total expense, including water, need not exceed \$7.75 per acre.

PROFIT.

The profit will vary with: 1st.—The cost of producing the crop. Every cent saved in producing the crop, so long as the yield is not affected, is clear gain. 2nd.—It will vary with the yield. Any increase in yield over the amount required for the expense of raising the crop is almost clear profit. 3rd.—It will vary with the market price realized. While none of our experiments have shown the expense to be greater than the value of the crop, still the apparent profit in one instance is only \$1.73 per acre. This is a little less than an income of seven per cent. upon a land valuation of \$25.00 per acre, and shows that wheat might not be profitable when the expense of raising the crop is large and the yield comparatively small. The profit ranges from \$1.73 to \$16.70 per acre, the average for the State in the three years' experiment being \$10.16 per acre. With

land at \$25.00 per acre this profit would be over forty per cent. on the investment, or a return of ten per cent. on a land valuation of \$100.16 per acre.

In the State Engineer's Report for 1892, (Page 31) it is stated that the average value of irrigated land for the arid region is \$83.28 per acre, but that the value of irrigated land in Wyoming is lower than this. It shows that if the land was given in homesteads, the average cost of land and water would not exceed \$10.00 per acre. But even with the larger valuation our results show that wheat is a profitable crop.

It may be noted that in the tables the cost of keeping up the ditches is included in the cost of irrigation. The first cost of getting the water to the land need not be taken into account as it is a part of the investment, the land valuation carrying the cost of water right with it. There is no way of determining the exact amount of taxes, so no account is taken of them. In computing his profit each farmer should deduct the amount of taxes from his total earnings.

EXPLANATION OF TABLES.—Tables I, II and III give the results for 1893, 1894 and 1895. The price per pound is the price at the local market at the time of harvest. Where two or three varieties were grown the acre plats were divided into two or three equal parts and the yield given is the total yield from the whole acre plat.

Table IV gives the averages for the time the experiment was in progress. Results from Saratoga are for only one season and consequently are not an average. The averages are for two seasons at Laramie and for three seasons at the other farms, excepting Saratoga.

TABLE III. COST AND PROFIT OF GROWING WHEAT. 1895.

PLACE.	VARIETY.	Yield, Pounds per Acre.	Price per Pound cts.	Value of Crop	Cost of Seed	Labor Putting in Crop.	Cost of Irrigation	Cost of Harvesting.	Cost of Threshing.	Total Cost.	Profit.
Laramie.	White Russian	1,707.5	1	\$17.07	\$1.26	\$2.60	\$0.75	\$3.00	\$1.50	\$9.11	\$ 7.06
Lander	Saskatchewan File	2,100	1 1/4	26.25	1.53	2.43	0.88	2.13	1.75	8.72	17.53
Sheridan	Velvet Chaff	3,542.5	3/4	26.57	0.67	3.00	2.25	2.89	2.73	11.54	15.03
Sundance	Whittington	1,320	5-6	11.00	1.00	3.00		3.00	1.52	8.52	2.48
Wheatland	Velvet Chaff	2,143	1 1-12	23.23	1.30	3.00	2.40	2.20	3.60	12.50	10.73

TABLE IV. AVERAGE COST AND PROFIT.

PLACE.	Years.	Yield per Acre.		Value per Acre	Cost per Acre	Profit per Acre
		Pounds	Bushels			
Laramie	1894 and 1895	1,904	31.7	\$19.03	\$10.15	\$ 8.88
Lander	1893, 1894 and 1895	1,580	26.5	19.95	10.78	9.17
*Saratoga	1894	2,410	40.2	24.00	7.30	16.70
Sheridan	1893, 1894 and 1895	2,521	42.0	22.25	12.10	10.15
Sundance	1893, 1894 and 1895	1,293	21.5	15.93	9.02	6.91
Wheatland	1893, 1894 and 1895	2,147	35.8	22.07	12.93	9.14
Average for the State -		1,976	32.9	20.54	10.38	10.16

* Only one year, not averaged.

SUMMARY.

Advantages of raising wheat under irrigation are: 1st, an assured crop; 2nd, larger yields; 3rd, heavier and better grain; 4th, maintaining fertility of the soil.

The cost of raising wheat varies from \$7.30 to \$13.36 per acre. Estimated cost upon 40 acres or more by the use of improved machinery, \$7.75 per acre.

Profit varies from \$1.73 to \$16.70 per acre.

Average profit is \$10.16 per acre, which is a ten per cent. income upon a land valuation of over \$100 per acre, or over forty per cent. upon a land valuation of \$25 per acre.



UNIVERSITY OF WYOMING.

Agricultural College Department.

Wyoming Experiment Station,

LARAMIE, WYOMING.

BULLETIN NO. 26.

DECEMBER, 1895.

GARDEN PEAS.

BY THE AGRICULTURIST AND HORTICULTURIST.

Bulletins will be sent free upon request. Address: . Director Experiment Station, Laramie, Wyo.

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GARDEN PEAS.

B. C. BUFFUM.

Thirty-eight varieties of peas were grown on the Experiment Farm the past summer, and sufficient data are at hand for publication in bulletin form. The season was unusually short and cold, and the following tables and notes will give those interested an idea of the varieties likely to do best under our most adverse conditions of climate. Their value depends upon the full and careful notes kept by my assistant, Mr. W. H. Fairfield, who has also given efficient assistance and suggestions in working up the data and putting them into their present form.

The pea belongs to the class of plants known as hardy annuals. They grow in cold climates and will flourish upon comparatively poor soil. Like other legumes they take nitrogen directly from the atmosphere, and are a rich food for both man and stock. Upon soils naturally deficient in vegetable matter, as is the most of our prairie or upland soil, they are valuable to plow under in the green state as a fertilizer.

While our market for garden peas is somewhat limited, still they are an important crop in every garden, and as field crops will prove of value for forage and feed, especial-

ly at high altitudes in the State, when in connection with rye, or other small grain, they will take the place of corn for fattening stock. As our population increases the information here given is in demand, and will directly benefit many who raise garden vegetables for their own tables.

There is an almost endless variety of peas, but probably the larger number of the standard sorts are given in Table I. All these have been grown upon the Laramie Farm for two or more seasons.* In 1894 their growth was not interrupted or retarded by any severe frosts, hail or other unusual climatic conditions. This season, however, has not been so favorable, and any variety which did well the past summer would give good returns under any ordinary conditions of climate likely to occur upon the Laramie Plains. All the varieties were planted April 19th and 20th, seed at the rate of 109 pounds per acre being used. The soil was dry, but all germinated from April 24th to 27th, and came up May 5th to 10th. The only cultivation was hoeing once on June 26th. They were irrigated on June 21st, July 9th, and August 21st and 22nd.

On June 17th an unusually severe frost injured all varieties more or less. In some from eight per cent. to twenty per cent. of the young plants were killed. In Table II these varieties are marked tender. Those showing no effects excepting that a few leaves were frosted are marked hardy, while those which were slow in recovering, still showing the injurious effects ten days after the frost, are marked half hardy. This frost and the cold weather

*Results with peas in 1894 were published in Bulletin No. 22, pp. 73 and 74.

caused the same varieties to be from one to three weeks later in reaching edible maturity than in 1894. Light hail-storms on July 17th and 22nd and August 8th left scars upon the pods which would injure their sale in the market, but they were not otherwise injured.

The same variety is sometimes given different names by different seedsmen. Among the kinds grown those which appear to be the same are as follows:

Blue Imperial Dwarf and Pride of the Market.

Cleaveland's Rural New Yorker, First and Best, Lee's Earliest and Extra Early Daniel O'Rourke closely resemble each other, the greatest variation being in their yields. Midsummer and Prince of Wales seem to be the same. Sterling and Alaska are much alike.

TABLE I.—None of the vines were staked up or trellised. The length of vines was determined, at the time ready for market, by straightening them out and measuring from the ground to the top leaf. The number of days in bearing is from the date ready for market to the time of last picking.

To determine the yield the rows were divided into two parts, leaving one to ripen seed and picking the other part as often as sufficient peas were ready. The weight of a gallon of each variety was carefully taken, and the amount of shelled peas produced by this gallon weighed. The weight of a gallon of peas in the pod varied from two pounds eleven ounces in Melting Sugar to three pounds nine ounces in Extra Early Premium Gem, the average being about three and one-fourth pounds. In varieties with medium sized pods the weight of a gallon was about 2½ per cent. less at the first picking than at the later pickings when the pods were better filled.

The weight of shelled peas from a gallon varied from seven and one-half ounces in Melting Sugar to one pound and eleven ounces in Lee's Earliest, the average being about twenty-two ounces. The shelled peas weighed twenty-one ounces per measured quart.

The number of days it took to mature is from the date the peas came up till they were ready for market.

The last column in Table I gives the value per acre of green peas at the local market wholesale price, which was $3\frac{3}{4}$ cents per pound. This shows that the better yielding sorts would be a very profitable crop where the market would warrant growing large areas, as the expense of growing them is comparatively small.

TABLE II.—The varieties are arranged first in reference to earliness, reconciling the results of 1894 and 1895 as nearly as possible, and secondly as to their yields, the earliest variety and heaviest yielder being put first in each case. From the column headed condition at time of frost information may be obtained in regard to those varieties which will be likely to ripen seed in a short season. The importance of the last column, headed hardiness, depends upon whether heavy frosts occur late in the spring after the peas are up.

TABLE I. GARDEN PEAS. 1895

Number	VARIETY.	First Blossoms	In Full Bloom	Ready for Market	Length of Vine, inches	Length of Pod, inches	Number of Days Maturing	Number of Days in Bearing	Yield per Acre of Green Peas, Shelled		Yield per Acre of Ripe Peas, pounds	Value per Acre of Green Peas
									Gallons	Pounds		
1	Admiral.....	July 8	July 22	Aug. 1	33	2 7	86	27	2,875	9,344	753 3,953	2,310 8350.40
2	Alaska.....	June 26	July 2	July 24	31	2 2	80	36	2,953	9,119	600 3,100	3,506 341.96
3	American Wonder.....	July 2	July 2	Aug. 1	17	3 0	86	29	564	1,809	148 775	516 70.09
4	Black Eyed Marrowfat.....	July 11	Aug. 1	Aug. 8	42	3 5	93	21	2,295	6,886	464 2,438	1,980 258.22
5	Bliss' Abundance.....	July 11	July 24	Aug. 1	22	3 0	85	17	975	3,168	267 1,401	1,485 118.80
6	Bliss' Everbearing.....	July 11		Aug. 1	22	3 0	86	17	1,319	4,286	330 1,731	1,403 160.72
7	Blue Imperial Dwarf.....	July 11		Aug. 1	31	3 0	93	16	2,569	8,348	642 3,372	949 313.05
8	Champion of England.....	July 8		Aug. 5	34	3 0	90	21	1,733	5,525	474 2,491	2,145 207.19
9	Cleaveland's Rural New Yorker.....	July 1	July 20	July 29	24	2 5	84	20	886	2,823	221 1,163	1,237 105.86
10	Dwarf Champion.....	July 11	Aug. 1	Aug. 8	24	3 2	93	16	1,944	6,317	532 2,794	1,155 236.89
11	Dwarf Wrinkled (Edible Pod).....	July 11	July 29	Aug. 8	26	2 5	97	14	2,979	10,054	851 4,468	2,227 377.02
12	Echo.....	July 16	Aug. 8	Aug. 12	29	3 7	93	16	267	2,600	227 1,192	577 97.50
13	Extra Early Daniel O'Rourke.....	July 1	July 16	Aug. 1	30	2 0	86	43	1,805	6,297	444 2,331	1,650 236.14
14	Extra Early Premium Gem.....	July 11		Aug. 1	16	2 5	86	43	650	2,316	193 1,016	247 86.85
15	Fill Basket.....	July 8	Aug. 8	Aug. 8	31	4 6	94	35	3,146	9,831	824 4,326	1,980 368.66
16	First and Best.....	June 26	July 16	Aug. 1	26	2 0	87	43	986	3,453	293 1,541	722 120.49
17	Forty Fold.....	July 8	Aug. 5	Aug. 5	42	2 8	90	38	2,162	7,028	515 2,702	1,815 263.56
18	Horsford's Market Garden.....	July 16	Aug. 5	Aug. 5	22	3 0	90	38	1,408	4,489	352 1,848	495 108.34
19	Land's Marrow *.....	July 8	Aug. 8	Aug. 8	47	2 7	93	35	1,313	4,022	428 1,723	412 150.82

*Probably Sander's Marrow.

TABLE 1.—Concluded.

GARDEN PEAS.

1895

Number	VARIETY.	First Blossoms	In Full Bloom	Ready for Market	Length of Vine, inches	Length of Pod, inches	Number of Days to Maturing	Number of Days to Baring	Yield per Acre of Green Peas, in Pod			Yield per Acre of Ripe Peas, pounds	Value per Acre of Green Peas
									Gallons	Pounds	Gallons	Pounds	
20	Lee's Earliest	July 2	July 16	Aug. 1	28 2.2	85	21	58	1,970	188	985	1,072	\$ 73.87
21	McLean's Advancer	July 16	Aug. 8	Aug. 8	18 2.7	90	11	43	1,483	118	619	247	55.61
22	McLean's Little Gem	July 16	Aug. 8	Aug. 8	24	91	11	264	975	85	445	62	30.56
23	Melting Sugar (Edible Pod)	July 8	July 16	Aug. 1	38 3.8	88	27	2,116	5,687	189	992	577	213.36
24	Midsummer	July 16	Aug. 8	Aug. 8	30 3.2	95	20	1,495	4,672	356	1,869	247	175.20
25	Pride of the Market	July 11	Aug. 2	Aug. 2	24 3.5	85	27	2,025	4,687	801	1,205	949	363.34
26	Prince of Wales	July 16	Aug. 1	Aug. 8	30 3.2	92	28	1,480	4,631	370	1,942	722	173.66
27	Renown	July 18	Aug. 1	Aug. 16*	32	100*	12*	325	1,036	66	345	247	38.85
28	Royal Dwarf Marrowfat	July 18	Aug. 1	Aug. 11*	32	96*	17	1,219	3,961	319	1,676	557	148.54
29	Laxton's Alpha	June 26	July 16	July 24	35 2.5	79	17	1,718	6,337	593	3,114	928	237.61
30	Sterling	July 8	July 8	July 29	33 3.2	83	19	3,365	10,095	641	3,365	3,011	378.56
31	Stratagem	July 11	Aug. 5	Aug. 5	40 3.8	91	24	1,347	4,042	305	1,599	742	151.57
32	Summit	June 26	July 24	July 24	33 2.5	80	23	824	2,783	225	1,184	1,052	104.36
33	Tall Sugar	July 8	Aug. 5	Aug. 5	40 2.5	92	32	1,556	5,058	481	2,528	1,567	189.67
34	Telegraph	July 8	Aug. 1	Aug. 1	33 3.7	86	29	1,219	3,961	247	1,295	392	148.54
35	Telephone	July 8	Aug. 1	Aug. 1	39 3.0	86	29	2,161	7,202	592	3,106	1,176	273.45
36	Tom Thumb	July 1	Aug. 1	Aug. 1	24 2.5	87	15	645	2,580	230	1,209	186	96.75
37	White Marrowfat	July 16	Aug. 5	Aug. 5	36 3.2	90	15	1,514	4,733	342	1,708	825	177.49
38	Yorkshire Hero	July 8	Aug. 5	Aug. 5	19 2.8	90	24	2,710	8,775	803	4,219	1,609	329.06

* Estimated.

TABLE II. GARDEN PEAS.

Number	VARIETY.	Ready for Market 1894	Ready for Market 1895	Condition of Vines Sept. 23*	Hardiness
1	Alaska	July 12	July 24	Ripening	Hardy
2	Sterling	Aug. 20	" 29	"	"
3	Admiral		Aug. 1	Green	"
4	Laxton's Alpha	July 28	July 24	Ripening	"
5	Extra Early Daniel O'Rourke	" 12	Aug. 1	Ripe	Half hardy
6	Melting Sugar	" 25	" 1	"	Tender
7	Summit		July 24	"	Half hardy
8	Bliss' Everbearing	July 26	Aug. 1	"	Hardy
9	Telegraph	" 26	" 1	Ripening	Half hardy
10	Bliss' Abundance	" 28	" 1	Ripe	Hardy
11	Tom Thumb	" 12	" 1	"	Tender
12	Extra Early Premium Gem	" 12	" 1	"	"
13	Cleaveland's Rural New Yorker	" 18	July 29	"	Half hardy
14	First and Best		Aug. 1	"	Tender
15	Telephone	Aug. 7	" 1	Ripening	Hardy
16	Lee's Earliest	July 12	" 1	Ripe	Tender
17	Yorkshire Hero	" 26	July 26	Ripening	Half hardy
18	Blue Imperial Dwarf	" 26	Aug. 8	Green	Hardy
19	Forty Fold		" 5	Ripening	"
20	Tall Sugar		" 5	"	"
21	American Wonder		" 1	Ripe	Half hardy
22	White Marrowfat		" 5	Ripening	" "
23	Black Eyed Marrowfat	Aug. 1	" 8	Green	Hardy
24	Champion of England	" 10	" 5	Ripe	"
25	Pride of the Market	" 11	" 2	Ripening	"
26	Stratagem	" 10	" 5	"	"
27	Prince of Wales	" 6	" 8	Green	Tender
28	McLean's Little Gem	" 1	" 8	Ripe	"
29	Fill Basket		" 8	"	Hardy
30	Dwarf Champion		" 8	"	"
31	Land's Marrow		" 8	Green	"
32	Midsummer		" 8	Ripe	Tender
33	Echo		" 8	"	"
34	McLean's Advancer		" 8	"	"
35	Horsford's Market Garden	Aug. 15	" 5	"	Half hardy
36	Dwarf Wrinkled		" 12	"	Hardy
37	Royal Dwarf Marrowfat	Aug. 15	" 11	Ripening	"
38	Renown		" 16	Ripe	Tender

*Time of killing frost

NOTES ON VARIETIES WHICH WE RECOMMEND FOR
GENERAL PLANTING.

Alaska.—An extra early variety and of this class the hardiest. Plants medium in size, dark green, of dense growth. Green peas smooth, of good quality. Ripe peas light green, smooth.

Sterling.—An early variety and one of the hardiest, with long season, vines of medium size, dark green, of dense thrifty growth. Gave the heaviest yield of any variety grown. Ripe peas, light green, smooth. Very much like Alaska.

Telephone.—Second early, and one of the hardiest and best yielding varieties. Vines large, of thrifty growth. Pods large, well filled. Ripe peas light green, wrinkled. This is of first quality, being one of the most delicious green peas in the list.

Telegraph.—Second early, not so hardy or good a yielder as Telephone, which originated from this variety. Vines of medium size. Pods large and shelled peas of good size. Ripe peas large, light green, wrinkled. Green peas sweet and of fine quality for the table.

Admiral.—A second early variety and one of hardiest and most prolific. Vines large, of thrifty growth. Pods of medium size. Ripe peas large, light colored, wrinkled.

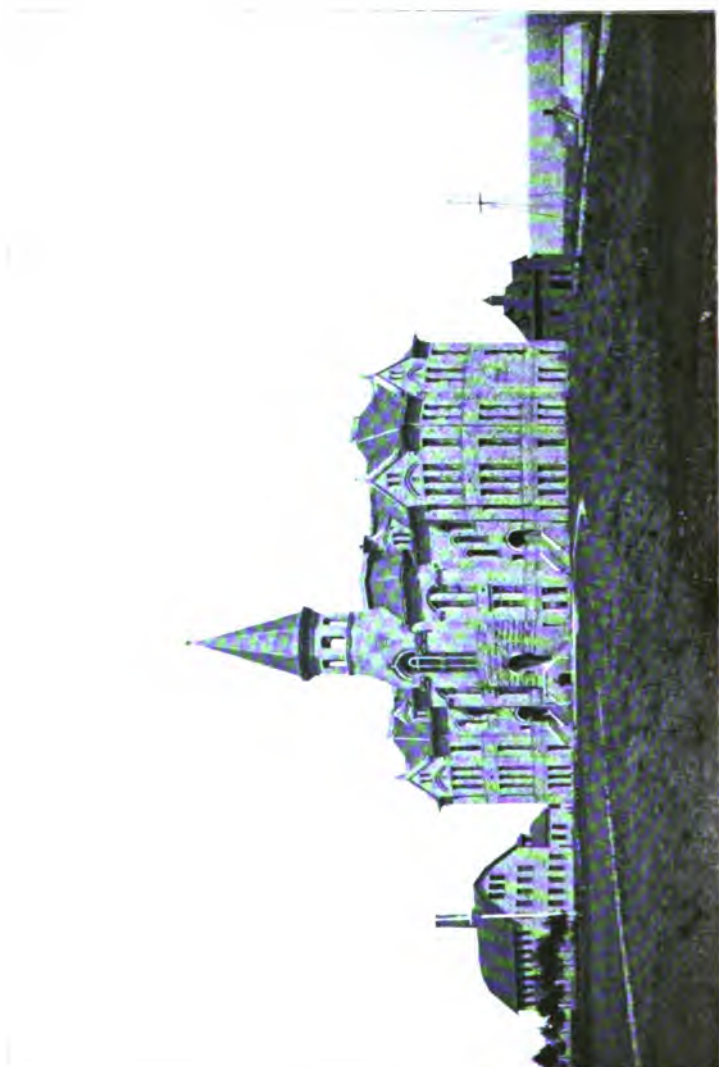
Blue Imperial Dwarf.—Probably same as Pride of the Market. A second early pea, hardy and one of best yielders. Vines of medium size. Pods large. Peas large and of good quality. Ripe peas large, light green, smooth.

Black-eyed Marrowfat.—One of the best late varieties.

Hardy, good yielder. Vines large and thrifty. Pods large. Peas of good size and quality. Ripe peas light colored, large, smooth, with black eye.

Melting Sugar.—Probably the best and most largely grown variety with edible pods. Did not withstand freezing as well as many other varieties, but is a fairly good yielder. Vines large. Pods large, crooked, light colored, stringless, and tender when young. Ripe peas light colored, large and smooth. The young peas cooked pod and all are of fine flavor.





1874

SIXTH ANNUAL REPORT

... OF THE ...

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AGRICULTURAL COLLEGE

... OF THE ...

UNIVERSITY OF WYOMING,

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WYOMING

AGRICULTURAL EXPERIMENT STATION,

FOR THE YEAR 1896.

126663

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LARAMIE, WYO.

THE REPUBLICAN BOOK AND JOB PRINT

1896



LETTER OF TRANSMITTAL.

*To His Excellency,
Hon. Wm. A. Richards,
Governor of Wyoming,
Cheyenne, Wyoming.*

In accordance with my duties as President and Director, I have the honor to present herewith the Sixth Annual Report of the Agricultural College of the University of Wyoming and of the Agricultural Experiment Station of Wyoming. This report is for the year 1896.

Copies will be sent also to all agricultural colleges, to the Secretary of the Treasury, to the Secretary of the Interior, and to the Secretary of Agriculture, in compliance with Sections 3 of Acts of Congress of August 30, 1890, and March 2, 1887.

Respectfully submitted,

Frank Pierpont Graves

UNIVERSITY OF WYOMING,
December 31, 1896.

University of Wyoming.

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Instructor in Mechanical Engineering.

SIXTH ANNUAL REPORT

. . . OF THE . . .

Agricultural College of the University of Wyoming,

FOR THE YEAR 1896.

I hereby submit the Sixth Annual Report of the Agricultural College of Wyoming, in compliance with enactments of Congress.

Inception of the College and Station.

The courses in agriculture and mechanic arts have, from the organization of the University of Wyoming, been regularly established departments. It was provided, moreover, in the act of incorporation that "as soon as the income of the University will allow, in such order as the wants of the public shall seem to require, the said courses in the sciences, and their practical applications, shall be expanded into full and distinct schools." The departments of Agriculture and Mechanic Arts were thus organized into separate colleges of the University shortly after January 10, 1891, when an act of the Legislature of Wyoming placed the control of the appropriations from the Morrill and the Hatch Acts of Congress in the hands of the Board of Trustees of the State University. The Morrill Act, approved August 30, 1890, was intended to aid the Agricultural and Mechanical Colleges in the various States, and the Hatch Act, approved March 2, 1887, was for the purpose of establishing an Agricultural Experi-

ment Station in each State. The Trustees of the University have for six years administered these federal appropriations in accordance with their original purposes, and it is with the progress during 1896 of the College and Station maintained by these appropriations that this report is concerned.

Present Management and Course.

The names of the Trustees of the University and their organization, together with the Agricultural Committee, will be found on the preceding page. The names of the Faculty of the Agricultural College, and the chairs filled by each member, also appear on the same page. Since several of the professors occupy similar chairs in the College of Liberal Arts, the State is saved considerable expense and a much better corps of instructors is maintained.

The course in agriculture and that in mechanic arts are appended to this report, and will be seen on examination to compare in standard very favorably with similar courses in the best institutions of the country. As the educational opportunities of the State advance, and the number of students increases, the requirements of the College of Agriculture and Mechanic Arts will be gradually raised, so as to keep pace with the times. Already some improvements for next year's catalogue are in contemplation.

Improvements in Equipment.

The condition of the laboratories and work shops is this year better than ever before. Large additions of apparatus have been made to each of the departments, especially to that of mechanical engineering. The department of physics has been entirely refitted, more space has

been given for the chemical lecture room, the herbarium has received large additions, and the number of saurians now collected for the study of paleontology amounts to nearly thirty. Several iron working machines have been added to the equipment of the mechanical shop. A new sink has been put in, the floor of the engine room has been freed from oil and grime, and newly painted, the missing window lights have been supplied, the stairs rebuilt, and the machines mended and regulated.

Urgent Needs.

The constant expansion of the departments of physics, chemistry, geology, paleontology, and biology, will not allow a new scientific building to be long delayed, if the college is to continue its progress. The work done in these departments is of the highest character, and a credit to the State. Suitable encouragement in the way of proper facilities should be secured for such progressive work.

We have suffered somewhat, too, for the want of dormitories for young men and women. There are many deserving young people in this State who crave the education afforded by our institution, but cannot pay their living expenses in Laramie. Until some means are provided them, the influence of the highest educational institution in the State will not be strongly felt outside of the University site. If the State would build two dormitories, at the cost of a few thousand dollars, we could furnish these ambitious young people with board at cost. This year the president and some of the faculty have established a dormitory for young men largely at their own expense. This dormitory has done a great deal of good, but the price of board is not yet as low

as it should be, and the faculty cannot indefinitely continue the expense.

Changes in the Faculty.

The faculty has been considerably strengthened by the acquisition of Professor Ridgaway and Mr. Gilkison. It is due to their efforts that such improvements have taken place in the physical laboratory and the mechanical shops. Each has given all his time to his department, and together they have saved the college more than \$1,000 by manufacturing various sorts of apparatus and attending personally to repairs. Mr. Ridgaway had been professor of physics and dean at the University of the Pacific for nearly twelve years, and Mr. Gilkison was at the time of his election assistant in mechanical engineering at the Colorado Agricultural College. The high grade of instruction previously given by the other members of the faculty has been maintained during this year.

Discipline.

The discipline of the students has been excellent this year, and the quiet of the halls and rooms has been noticed by many visitors. One serious infraction only, that of hazing, occurred at the opening of the fall term, and this was promptly checked and punished by action of the faculty. The students have throughout the year shown the greatest interest in the welfare of the institution.

Increase in Numbers.

The numbers of the University as a whole have increased more than one-third over the highest previous record, and the indications for next year are still more promising. Students for the agricultural college are beginning to come in, and, although Wyoming has until recent

years been supposed not to be an agricultural State, it is certainly growing rapidly in this direction. The number of young men taking work in the shops amounts to nearly one-sixth of the University, and the facilities afforded the students in mining by means of this branch are almost indispensable. This training is very popular and valuable for the youth of a new State rich in physical resources.

Account of Departments.

The following is a detailed report of each department of the Agricultural College :

POLITICAL AND SOCIAL SCIENCE.

This department includes civics, public law, political economy, and sociology. Its aim has been to cultivate independent thought and foster intelligent citizenship. After the origin and growth of each subject has been investigated, and the general principles have been acquired, the student is required to apply the principles thus obtained to leading problems of the present day. Debates, public and private, form an important feature of the courses. The following subjects have been taught in this department in 1896 :

I. CIVIL GOVERNMENT. Fiske's Civil Government ; Bryce's American Commonwealth ; Macy's Civil Government. Lectures and practical illustrations. *Required of preparatory students.*

II. CONSTITUTIONAL LAW. Cooley ; Black. Examination of cases : lectures ; debates. *Elective for seniors.*

III. INTERNATIONAL LAW. Walker ; Gallaudet ; Woolsey ; Snow's Cases. Lectures ; debates ; theses. *Required of seniors.*

IV. POLITICAL ECONOMY. Ely's Introduction; Walker; Marshall; Gregory. Lectures; debates; theses. *Required of seniors.*

V. SOCIOLOGY. Small and Vincent; Giddings; Kydd's Evolution. Lectures; debates; theses. *Required of seniors.*

BIOLOGY.

The following subjects have been taught in the Department of Biology:

I. GENERAL BOTANY. It is the purpose of this course to give the student a general idea of the plant world as a whole, but especially to acquaint him with the main facts of the morphology and physiology of the seed producing plants. To this end, laboratory work in which these facts may be had largely at first hand, is made a prominent feature. During the spring term the students are brought into touch with the abundant and varied mountain flora of Wyoming, and each student acquires the ability to work out for himself the classification of the plants in which he may become interested. *Required of freshmen.*

II. PLANT MORPHOLOGY. In this course the classification and morphology of some of the spore producing plants receive attention. Incidentally a brief review of the relation of the spore producing to the seed producing plants is given. Type plants of the important groups are worked out by the student, and this knowledge is made the basis for the co-ordinating view of the whole field which the lectures seek to give. *Required of sophomores.*

III. GENERAL ZOOLOGY. A general course in which the main problems or generalizations of the subject receive

the first attention. Incidentally the general scheme of classification with the characteristics of the several groups is developed. *Required of sophomores.*

IV. MORPHOLOGY OF INVERTEBRATES. A study of the morphology and classification of types of the leading groups with special reference to the invertebrates. *Elective for juniors and seniors.*

V. PHYSIOLOGY OF VERTEBRATES. A course in the anatomy and physiology of the vertebrates. In this course the anatomy of the vertebrate classes is studied comparatively, and some of the problems connected with the successive modifications of the organs of vertebrates are considered. *Elective for juniors and seniors.*

The facilities for work in this department have been increased by reason of more and better laboratory apparatus and supplies. A number of additions to the reference library of the department is also worthy of record.

PHILOSOPHY.

The work in psychology was more satisfactory than in any previous year. This was due largely to the introduction of such experiments as could be made with inexpensive apparatus, described in Dr. Sanford's Laboratory Course, *American Journal of Psychology*, Vol. VI and V. Special attention was given to physiological psychology.

In teaching logic, without undervaluing deductive reasoning, more time than formerly was given to inductive reasoning. A perfect knowledge of this form is especially helpful to students in the study of the sciences, and to the graduates of the agricultural department in their original investigations and experiments.

In the study of ethics special stress was laid on the part which treats of the citizen and his duties. The study of these duties—such as the relation of the citizen to his government, obedience to civic laws, support of government, proper use of the ballot, etc., cannot but raise the ideal of citizenship.

I. PSYCHOLOGY. Sully ; Titchener ; James. Lectures ; experiments ; essays. *Required of juniors.*

II. LOGIC. Jevons ; Davis ; Mill. Lectures ; problems ; essays. *Required of juniors.*

III. ETHICS. Bowne ; Hyslop ; Mark Hopkins, and various books of reference. Lectures ; discussions ; problems ; essays. *Elective for juniors and seniors.*

IV. HISTORY OF PHILOSOPHY. Various books of reference. Lectures ; researches ; theses ; discussions. *Elective for seniors.*

AGRICULTURE AND HORTICULTURE.

Our facilities for teaching practical and scientific agriculture have been augmented by the purchase of some improved machinery and a number of new books for our library. Our agricultural museum has been increased during the year by the addition of a large amount of material. It now contains a part of our grass collection which took a medal at the World's Fair, many representative crops from foreign countries and states, as well as those from different parts of Wyoming, and samples of nearly all the varieties of wheat, oats and barley that the world has produced. The collection is of interest and a valuable aid to the student. Our facilities for teaching scientific agriculture may be said to be equal to, or better

than those in most of our universities. All instruction is by lectures.

Any one not able to take the regular course of four years, but who can give the time for some instruction, is cordially invited to our courses for one and two years. We also offer university extension courses in agriculture and horticulture to classes who organize and request the same. We are ready to organize courses in irrigation, engineering and dairying upon request. Students desiring to take work not given in our catalogue should correspond with us before the term opens.

COURSES IN AGRICULTURE AND HORTICULTURE.

I. PRACTICAL FARMING. History of agriculture ; brief review of the chemical composition and physical properties of air and water as related to the soil and vegetation ; the chemical constituents and practical classifications of soil ; properties, treatment, and adaptation of each kind ; arid soils and retention of soil moisture ; history and methods of irrigation ; improvement of soils ; fallowing and green manuring ; manufacture, preservation, and application of manures and stimulants ; farm implements and machinery ; production, management, and sale of the different crops ; intensive farming ; forestry ; the different breeds of farm animals, their characteristics and adaptations ; breeding, rearing, feeding, and management for different purposes to which each is suited ; dairying, butter making, creameries and cheese factories ; selection and purchase of farms and ranches ; road making, fences, and farm buildings. *Required of freshmen and sophomores.*

II. HORTICULTURE. Relations of heat, light, moisture, and food to plant growth, and the means of controlling their supply and intensity in plant houses and hot-

beds ; soils and fertilizers and their manipulation : origin of cultivated plants ; propagation of plants ; grafting, budding, pruning, and training ; planting and transplanting ; hybridizing, crossing, and selecting ; cultivation of large and small fruits ; kitchen gardening, market gardening, landscape gardening, and floriculture. *Required of seniors.*

III. VETERINARY MEDICINE AND SURGERY. Prevention and treatment of diseases and injuries of the domestic animals. *Required of seniors.*

IV. COMPARATIVE ANATOMY AND PHYSIOLOGY. Anatomy, physiology and hygiene of the domestic animals and cultivated plants ; diseases of plants ; vegetable parasites. *Required of sophomores.*

V. ECONOMIC ENTOMOLOGY. The class instruction embraces lectures upon the anatomy of insects ; their transformations, development, geographical distribution, and the principles and characteristics of classification. Special attention is given to the insects of Wyoming, and the most approved methods of checking their ravages. Each student is required to make a collection of Wyoming insects, which must be named and arranged in a systematic manner. During the term an essay relating to some feature of systematic or economic entomology is prepared by each student under the direct supervision of the instructor. In the laboratory students are required to make careful dissections and drawings of at least one insect in each order. *Required of juniors.*

VI. METEOROLOGY. Climatology ; relations of heat, sunlight, moisture, pressure of atmosphere, and evaporation, to climate ; laws of storms and climatic conditions ; instruments, their use ; reductions of observa-

tions ; hypsometry, thermometry, barometry, precipitation, effects of climate on plant distribution and growth. *Required of juniors.*

CHEMISTRY.

The following courses of study in the chemical department have been taught :

I. ELEMENTARY CHEMISTRY. Three hours lectures and four hours laboratory work a week. The aim of this course is to give students a knowledge of the laws of chemical change, a practical familiarity with the principal elements and compounds, and skill in the manipulation of apparatus. *Required of sophomores.*

II. QUALITATIVE ANALYSIS. Laboratory work ten hours a week. *Required of sophomores.*

III. QUANTITATIVE ANALYSIS. Laboratory work ten hours a week, fall and winter terms. *Required of mechanical juniors.*

IV. ORGANIC CHEMISTRY. Lectures and recitations five hours a week. *Required of agricultural seniors.*

V. AGRICULTURAL CHEMISTRY. Lectures and laboratory work on the chemistry of plant growth and the application of chemical principles to practical agriculture, with special reference to the problems of the arid region. *Required of agricultural juniors.*

The professors of chemistry and geology have been engaged in a study of the petroleum of Wyoming for several years. In October, 1893, were published analyses of oil from the Shoshone reservation; from the Murphy wells, Fremont county; from the Salt Creek basin, Natrona county, and from Belle Fourche, Crook county. In January, 1895, a special bulletin was published by the profes-

sors of chemistry and physics on methods of determining the heating power of petroleum and giving the fuel value of eight samples of Wyoming petroleum.

The past year the professors of chemistry and geology have been enabled to carry on the work more systematically, and it is their intention to make a comparatively thorough test of each field in the State. The Salt Creek field was chosen for the first investigation, as it was the best developed. A still of one barrel capacity was constructed, which enables the distillation to be carried out on a scale which gives a fair idea of the character of the commercial products. The Salt Creek oil was separated into about 250 fractions, which were tested for gravity, flashing point, burning point, freezing point and viscosity. Distillations were made without steam, with super-heated steam and under diminished pressure, and the products compared with commercial lubricating oils. The results of this investigation were published June, 1896, in Bulletin No. 1, Petroleum Series.

The Lander oil field was next studied in a similar way. Samples from three localities have been analyzed, and one of them distilled in quantity. The results are now almost ready for the press, and will soon be published as Bulletin No. 2, Petroleum Series. Other fields of the State will be investigated as rapidly as time will permit, and one or more bulletins on the subject will be published each year.

The professor of chemistry is now giving in Laramie a university extension course on the chemistry of food, which will probably be repeated in other cities.

GEOLOGY.

The regular work in geology required from all students is a course requiring five hours per week for three consecutive terms, and a thesis upon some subject to be selected by the student under the direction of the instructor during the second term. This course will deal with general geology, and is intended to give the student a thorough and comprehensive idea of the great study.

Besides the regular course, studies in advanced geology are offered to those who wish to make a specialty of this subject or of any of its branches. It is absolutely necessary for a student who wishes to become proficient in this line of study to go into the field and study from nature. The opportunities for students to study geology at the University of Wyoming are, in many respects, superior to those in many institutions of learning. The University is located upon triassic rocks; to the east rise the Laramie mountains, flanked by paleozoic rocks; to the west are series of jurassic and cretaceous rocks, beyond which are the Medicine Bow mountains, and only twenty miles away there is an extensive development of tertiary rocks. The mountains on either side have an archæan core which is well mineralized. The sedimentary rocks are rich in invertebrate and vertebrate fossil life, and also have valuable deposits of clay, gypsum, soda, and coal. The nearness of the mines of gold, silver, copper, lead, iron, and coal, and the quarries of limestone, sandstone, marble, and granite, makes the location one of great value to the student of geology.

There are in course of construction two geological maps, one of the State and one of the immediate vicinity of the University. for the use of students. The latter map

will be drawn on the scale of two inches to the mile, and will include the geology of the country for a radius of twenty miles from the University.

COURSE IN GEOLOGY.

I. GENERAL GEOLOGY. Fall, winter and spring terms ; five hours per week ; forty hours field work and a thesis. *Required of seniors.*

II. MINERALOGY. Five hours per week for twelve weeks. *Required of seniors.*

III. ECONOMIC GEOLOGY. Five hours per week for twelve weeks ; twenty-four hours field work. *Elective for seniors.*

IV. PALEONTOLOGICAL GEOLOGY. Five hours per week for twelve weeks. *Elective for juniors and seniors.*

V. FIELD WORK AND THESIS. Five hours per week for twelve weeks ; sixty hours in field work. *Elective for seniors.*

Text and reference books used : Dana, Geikie, Kemp, Le Conte, Williams, Tarr, and Nicholson.

HISTORY.

As the aim of this department is to create a taste for historical reading, the course has been arranged so that a student may take some subject of history each year. The courses taught are as follows :

I. UNITED STATES. Barnes' United States history ; Fiske's civil government. Lectures ; essays. *Required of sub-preparatory students.*

[The Board of Trustees having abolished the sub-preparatory class, this course will not be given in the future.]

II. ENGLAND. Montgomery's history of England. General outline taught by text-book ; lectures and essays. *Required of freshmen.*

III. GENERAL HISTORY. Myer's general history and various reference works. *Required of freshmen.*

IV. FRANCE. Montgomery's French history, supplemented by general reading and lectures. *Required of sophomores.*

V. MIDDLE AGES. Emerton ; Church ; Thacher and Schwill. Lectures ; essays. *Elective for sophomores.*

VI. HISTORY OF CIVILIZATION. Adams ; Guizot ; and various books of reference. *Elective for juniors.*

VII. SPECIAL PERIOD. Seminary study of some epoch, such as the reformation or the rise of Prussia. *Elective for seniors.*

VIII. PHILOSOPHY OF HISTORY. Taught entirely by lectures and quizzes. Many books of reference are used. *Required of seniors.*

ENGLISH.

At the opening of the fall term the English department was relieved of its sub-preparatory course, and its work was enlarged and strengthened.

During the past year one hundred and thirty students have received instruction in this work.

The following courses have been given :

I. Lockwood's lessons ; English classics. Selections from the following authors were read : Irving, Longfellow, Whittier, Hawthorne, Holmes, Lowell, and Bryant. *Required of preparatory students.*

II. Essays upon the following works and the authors represented : Shakespeare's *As You Like It* ; DeFoe's

History of the Plague in London ; Irving's Tales of a Traveler ; Hawthorne's Twice Told Tales ; Longfellow's Evangeline ; Eliot's Silas Marner. *Required of freshmen.*

III. Pancoast's history of English literature. Six representative writers ; early English. *Required of juniors.*

IV. Genung's rhetoric and rhetorical analysis ; English drama and Shakespeare ; English lyric and English prose ; American literature. *Required of seniors.*

V. Whitney's life and growth of language ; Anglo-Saxon ; middle English. *Elective for seniors.*

RHETORICALS.

The work in elocution and oratory is of a practical character. The aim is to give students such training as shall best prepare them for the duties of citizenship. As far as possible the instructor gives each student personal attention, that the respective needs may be learned, and that such instruction may be imparted as shall be productive of the best results. This work is done through literary divisions and through the special oratorical drill of the senior year. One hundred and twenty-two students have during the past year received practice through frequent exercises in the delivery of original composition or of selections from standard authors.

MILITARY SCIENCE AND TACTICS.

The total number of students admitted to the military department for the year is as follows :

Winter term, thirty-three (33.)

Spring term, thirty-six (36.)

Fall term, forty-nine (49.)

Average for three terms, thirty-nine (39.)

It will be seen that the numbers are increasing.

As a rule these students have reported for instruction four times per week.

The equipment and instruction is the same as reported heretofore.

MATHEMATICS.

The following courses are taught :

I. ELEMENTARY ALGEBRA. Fundamental operations, factoring, fractions, simple equations, involution, evolution, radicals, surds, quadratic equations, simultaneous equations above the first degree, and theory of indices. *Required of freshmen.*

II. PLANE GEOMETRY. Including the general properties of regular polygons. Great stress is placed upon the solving of original problems. *Required of sophomores.*

III. SOLID GEOMETRY. *Required of juniors.*

IV. ADVANCED ALGEBRA. Functions and their notations, series and the theory of limits, general theory of equations, imaginary quantities, and the theory of elimination by determinants. *Required of freshmen.*

V. PLANE TRIGONOMETRY. The development of the general formulae, and their application to the solution of triangles, polygons and original field problems. *Required of juniors.*

VI. ANALYTICAL GEOMETRY. The analytical geometry of the straight line, circle, and conic sections, including a discussion of the general equation of the second

degree, and some special examples in higher loci. *Required of mechanical juniors.*

VII. DIFFERENTIAL CALCULUS. Development of the fundamental principles and formulae of the differential calculus; derivatives of higher orders, successive derivatives, development in series, maxima and minima of functions. *Required of mechanical juniors.*

VIII. INTEGRAL CALCULUS. Elementary forms of integration, double integral, triple and multiple integrals, lengths of curves, areas, volumes, etc. *Required of mechanical juniors.*

IX. SURVEYING. Chain surveying, compass and transit surveying, declination of the needle, laying out and dividing land, plane table surveying, the survey of the public lands, city surveying, mine surveying, and the judicial functions of the surveyor. *Required of mechanical sophomores.*

X. ANALYTICAL MECHANICS.	} <i>Required of mechanical seniors.</i>
XI. MECHANICS OF MATERIALS.	
XII. THERMODYNAMICS AND HY- DRAULICS.	

PHYSICS.

The chief aims of the department of physics are to assist students in acquiring a thorough and practical knowledge of physical phenomena through work performed in the laboratory, and to aid them in becoming skilled in laboratory methods.

The courses have been somewhat modified from those presented last year, and two additional electives are offered, one in Electrostatics and the other in Electrodynamics. In all courses laboratory work of a quantitative

character is now required in connection with the study of prescribed text books and attendance upon lectures.

The method of conducting the laboratory work, especially in the elementary classes, is that which is sometimes called the "collective system." Under this method all are engaged on the same experiment at the same time, thus allowing the teacher the opportunity of instructing the entire class at once upon any difficult points which may arise, and still leave him free to devote the greater portion of his time to assisting those who are naturally slow in comprehending and performing experiments.

The interior arrangement of the room, formerly used as a lecture room, has been entirely remodeled into a laboratory, which can very comfortably accommodate sections of twenty students each. Five new tables have been constructed and placed in convenient positions around the room, and a large cabinet has been built to contain the apparatus when not in use. Much new apparatus was procured for the laboratory during the summer, to be used especially for quantitative work in both the elementary and advanced classes.

The following courses are open :

I. ELEMENTARY PHYSICS. Three hours recitations, and four hours laboratory work per week. *Required of freshmen.*

II. GENERAL PHYSICS. Three hours recitations and lectures, and from four to six hours laboratory work per week. *Required of juniors.*

III. MAGNETISM AND ELECTROSTATICS. Laboratory work from six to ten hours per week. *Elective for mechanical seniors.*

IV. ELECTRODYNAMICS. Laboratory work from

four to six hours per week. *Elective for mechanical seniors.*

MECHANICAL ENGINEERING.

The department of mechanical engineering is in a very prosperous condition.

During the summer vacation the iron room was fitted with machines, so that we are now prepared to do as many different kinds of machine work as are done in similar institutions.

The following list of iron working tools has been added : One 24in.x24in.x6ft. G. A. Gray planer ; one No. 1 Universal Brown & Sharp milling machine ; one 25in. Davis & Egan back geared power feed drill press ; one Detroit emery grinder with two 14in. emery wheels. These machines, together with the 14in. Hendey-Norton screw cutting lathe that was in the room, permit a wide scope of metal work. These machines rank as high as any manufactured. Each machine is supplied with necessary tools to do the work for which it was designed.

A Champion lever forge, with a full set of forge tools, anvil, tongs, cutters, etc., was placed in the forge room to sharpen and temper iron working tools. There has been added also to the machine room a complete set of piping tools. These not only will enable the student to become familiar with steam fitting, but will be the means of effecting a saving of no small importance to this and other departments of the University.

Few things were supplied to the wood working room, as it was found to be thoroughly equipped for the required work. The wood working machinery was made by first-class manufacturers. Each bench and lathe is provided

with a course of work selected from some of our leading institutions. The object of such a course is to teach the student to read mechanical drawings and cause him to place thought in his work. The exercises that were selected are such that to do satisfactory work the student must have a clear idea of the task before him. In addition to the regular course in wood working, many useful articles are made for different departments of the University. When necessary, the student designs the work in the drafting room, from which the articles are constructed in the shop.

Apparatus for experiments in mechanical engineering will be added to the department as rapidly as it can be constructed.

Many new copies, both for mechanical and free hand drawing, have been added to the drafting room. This year the students were induced to purchase a better grade of instruments, thus enabling them to do more satisfactory work.

Some valuable additions have been made to the books on mechanical engineering, thus placing before the student one of the essential features of success, a good library.

If this department continues to receive the generous support that has been given it in the past, we will soon hold high rank among mechanical institutions.

THE LIBRARY.

The library, which is also the general reading room of the University, is situated on the second floor, in the north wing of the main building. This is a large, well lighted and ventilated apartment. The college students

use this room during vacant hours from 8.39 a. m. to 12 m., and from 1 to 3.15 p. m.

The students at all times during the day, for five days in the week, have free access to all the books and periodicals. Three volumes may be taken by any one individual and kept from the shelves for a period of two weeks. Books reserved at the instance of professors as collateral reading for their courses are shelved in their respective rooms, and can be taken out only on application to such professors, who are responsible for them during the period of their reservation.

The library contains 4,450 bound volumes, and in addition several thousand unbound bulletins and reports on agricultural and scientific subjects.

There have been added to the University library, during the year 1896, 532 bound volumes and 600 pamphlets, including Experiment Station bulletins and publications from the Department of Agriculture at Washington, D. C.

The Board of Trustees of the University, at its annual meeting in June, 1896, made an appropriation of nine hundred and twenty-five dollars for reference books for the library. The scientific books as purchased, after being catalogued, are placed in the reference libraries in the respective laboratories in the University, the books for more general use being placed in the library proper. A pleasing increase of interest in the library has been shown by the students during the past year; the books are consulted with greater care, and the knowledge obtained has been particularly noticed in the departments of English and history.

The following list of agricultural papers and Wyoming newspapers is sent to the University :

Arkansas—	Illinois—
Farmer.	Prairie Farmer.
California—	Orange Judd Farmer.
Press and Horticulturist.	Farmers' Review.
The Call.	The Farmer's Magazine.
West American Science.	The Elgin Dairy Report.
Colorado—	Irrigation Age.
Farmer.	Iowa—
The Mining Review.	Iowa Homestead.
The Field and Farm.	Kansas—
Georgia—	Farmer.
The Southern Cultivator.	Kentucky—
Indiana—	The Industrial American.
Clover Leaf.	New México—
Louisiana—	Southwestern Farm and
Planter.	Orchard.
Maryland—	New York—
Farmer.	American Agriculturist.
Baltimore Weekly Sun.	Rural New Yorker.
Southern State.	Sugar Trade Journal.
Massachusetts—	Ohio—
Farm and Home.	American Grange Bulletin.
Ploughman.	Pennsylvania—
Our Grange Home.	Germantown Telegraph.
American Cultivator.	Public Ledger, daily.
New England Farmer.	Virginia—
Michigan—	Southern Planter.
Grange Visitor.	The Progressive South.
Missouri—	Washington—
National Dairyman.	Northwest Mining Review.
Nebraska—	Wisconsin—
Western Resources.	Hoard's Dairyman.
New Hampshire—	Ontario—
Mirror and Farmer.	Farmers' Advocâte.

State Papers—

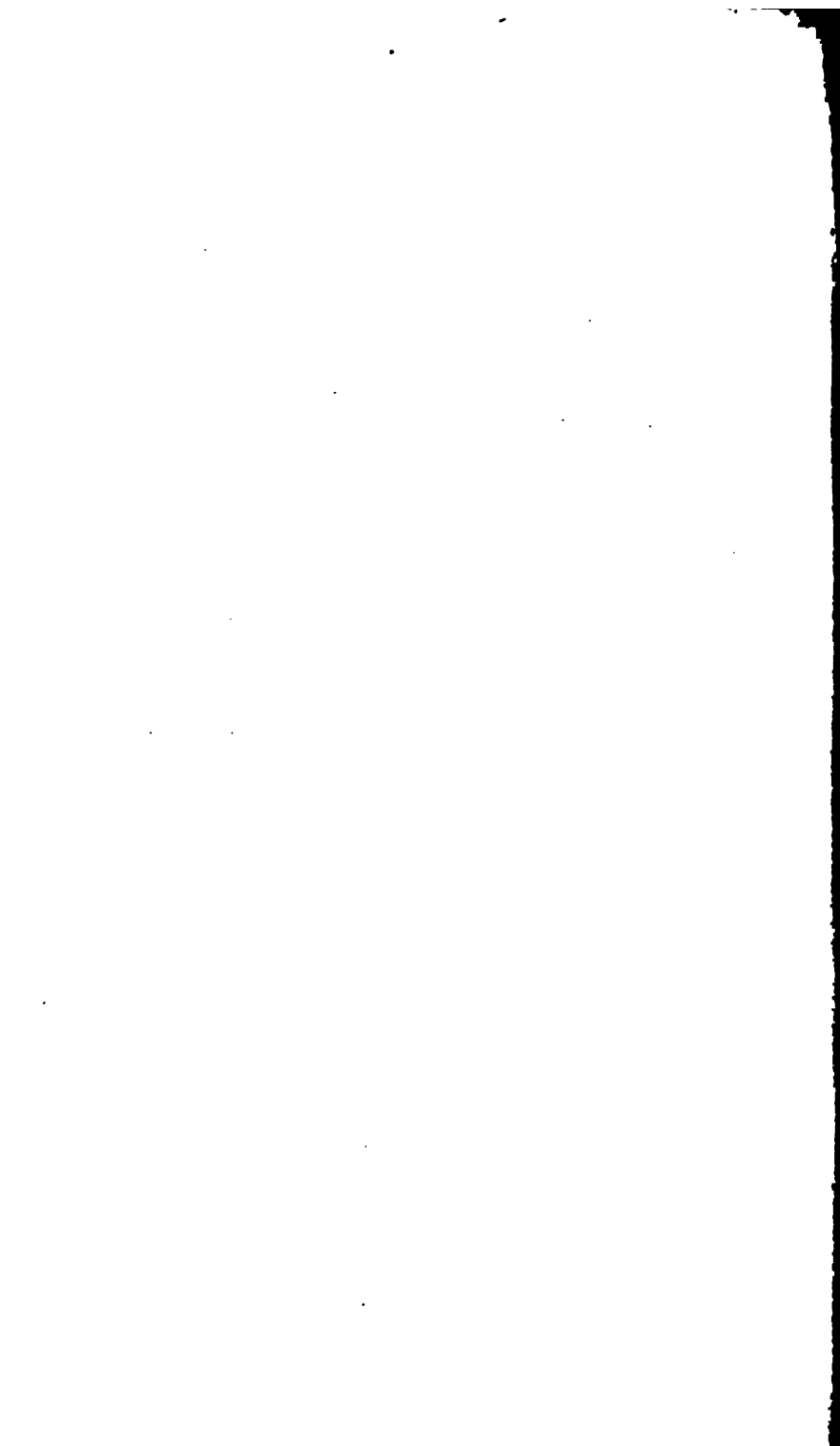
Bill Barlow's Budget.	News-Register.
Black Diamond.	Otto Courier.
Boomerang.	Rock Springs Independent.
Carbon County Journal.	Rock Springs Miner.
Central Wyoming News.	Saratoga Lyre.
Cheyenne Tribune.	Saratoga Sun.
Fremont County Gazette.	Sheridan Journal.
Green River Star.	Sheridan Post.
Laramie Republican.	Sun-Leader.
Laramie Times.	Wheatland World.
New Castle News-Journal.	Wyoming Press.

The scientific and general periodicals taken by the library and kept on the tables of the reading room are :

American Machinist.	Cosmopolitan.
Arena.	Colliery Mining Magazine.
American Naturalist.	Education.
American Gardening.	Educational Review.
American Journal of Science.	Electrical World.
American Geologist.	Engineer Magazine.
American Journal of Civics.	Erythea.
American Journal of Mathe-	Etude.
matics.	Fliegende Blätter.
Agricultural Science.	Forum.
Annals of American Acad-	Garden and Forest.
emy of Political and Social	Harper's Weekly.
Science.	Harper's Monthly.
Bulletins of the Torrey Bo-	Independent.
tonical Club.	Journal Society of Chemical
Botanical Gazette.	Industry.
Book News.	Journal of the Chemical So-
Century.	ciety.

Literary Digest.	Popular Science Monthly.
Meehan's Magazine.	Psychological Review.
Meteorological Journal.	Philosophical Review.
Microscope.	Quarterly Journal of Pure
Microscopical Journal.	and Applied Mathematics.
Mining and Scientific Press.	Review of Reviews.
Monist.	Science.
Nation.	Scientific American and Sup-
Nature.	plement.
North American Review.	Scribner.
Outlook.	Western Electrician.
Physical Review.	

The University uses the Dewey Decimal Card Catalogue system, and in addition to the regular cards we have those coming from the Department of Agriculture at Washington, containing a complete list of publications sent from that department and its several branches in connection with the Experiment Station work.



APPENDIX.



A. Courses of Study.

B. Treasurer's Report.

A. Courses of Study.

COLLEGE OF AGRICULTURE.

The college of agriculture, State of Wyoming, now offers to the youth of Wyoming the following courses of instruction in agriculture, mechanic arts, and military science :

I. A ONE YEAR'S COURSE.

For those whose time is limited, but who wish some practical instruction in farming and ranching. The studies are so arranged that students from the district schools can enter at the beginning of any term. The recitations and lectures are with the regular classes, a certificate is given for work done, and the grades may be credited toward the longer courses. The fall term includes : bookkeeping or physiology, drawing, English grammar or rhetoric, arithmetic or algebra, agriculture, and wood-working. The winter term embraces : bookkeeping, history and principles of agriculture, botany, horticulture, arithmetic, algebra, and metal-working. The spring term is devoted to : bookkeeping, civil government, the agriculture of soils and tillage, botany or horticulture, zoology, geometry, and field and laboratory work.

II. A TWO YEARS' COURSE.

Including the above, and selected studies from the second and third years of the complete course.

III. A FOUR YEARS' GRADUATING COURSE.

Devoted to a thorough training in agriculture. (See course of study).

IV. A GRADUATE COURSE.

For graduates who wish to devote their time to special research in the fields and laboratories of the Agricultural Experiment Station.

V. SPECIAL CHEMICAL COURSE.

The chemical laboratory is fitted up with a view to making it as useful as possible to the State at large, and good opportunities are offered for carrying on special investigations, or courses of study. The study being individual, and not in classes, courses can generally be arranged to suit the student. The only requirement is sufficient previous knowledge to undertake the line of work desired. Tuition is free. Apparatus broken and chemicals used are charged at cost.

EXPENSES.

Tuition is free to all resident students of Wyoming; non-residents will be required to pay an annual fee of \$5.00. An incidental and library fee of \$2.50 a year must be paid by all students.

SCOPE OF THE COLLEGE.

The College of Agriculture is designed to give to young men who may desire it the advantages of a thorough, liberal, and practical education, not only to prepare

them for the successful prosecution of agriculture in all its branches, but to secure to the student the mental discipline and training necessary to qualify him for any other calling or profession, and fit him to discharge intelligently the duties of an American citizen. The period of study requisite for graduation will extend through four years.

Students completing the course will receive the degree of Bachelor of Agriculture, and such students pursuing one year of graduate studies in the University will receive the degree of Bachelor of Science.

REQUIREMENTS FOR ADMISSION.

Students will be admitted to the agricultural course by passing a satisfactory examination in arithmetic, English grammar and composition, physiology, United States history, physical geography, and elementary algebra.

COURSE OF INSTRUCTION.

The instruction in this college will be given at the University building, and the practical instruction will be given on the agricultural college farm and at the Experiment Station at Laramie.

Agricultural College Course.

FRESHMAN.

FALL TERM.	WINTER TERM.	SPRING TERM.
Algebra, English History, Physics, Drawing, Shop Work, 2 hours.	Algebra, Agriculture, Physics, Botany, I., General History.	Algebra, Agriculture, Physics, Botany, I., General History.

SOPHOMORE.

Algebra, Advanced Physiology, Chemistry, I., Botany, II., French History.	Plane Geometry, Agriculture, Chemistry, I., Zoology, I., French History.	Plane Geometry. Agriculture, Chemistry, II., Zoology, II., French History.
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JUNIOR.

Solid Geometry, Psychology, Entomology, English, III.	Mechanics, Logic, Entomology, English, III.	Plane Trigonometry, Agricultural Chemistry, Agricultural Engineering, Meteorology, English, III.
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SENIOR.

Political Economy, Horticulture, Veterinary, Geology, English, IV.	International Law, Horticulture, Geology, Sociology, English, IV.	Thesis, Landscape Gardening, Organic Chemistry, Mineralogy, Veterinary.
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Military drill and rhetoricals throughout the course. Afternoons for laboratory and field work. To lead to the degree of B Agr. Graduate courses leading to degree of B. S. & M. Agr.

COLLEGE OF MECHANIC ARTS.

ADMISSION.

Students will be admitted to the mechanical course by passing a satisfactory examination in arithmetic, English grammar and composition, physiology, United States history, physical geography, and elementary algebra.

SPECIAL INSTRUCTION IN MECHANICAL DEPARTMENT.

For students desiring special instruction in mechanical drafting, higher theoretical mechanics and engineering, the new course of study in the mechanical department, is especially adapted. Mechanical drafting can be commenced in any term and be pursued as rapidly as the skill of the student will permit, as all work depends solely upon the student's ability.

Any branch of the higher mechanics can be pursued, if the elementary principles are well understood by the student.

Mechanical Course.

PREPARATORY.

FALL TERM.	WINTER TERM.	SPRING TERM.
Algebra, 5. Elementary Physics, English, 3, Mechanical Drawing,	Algebra, 5. Elementary Physics, English, 3, Mechanical Drawing, 5.	Algebra, 5. English, 3, Free-hand Drawing.

Rhetorical work same as other courses.

Shop work two hours each afternoon.

FRESHMAN.

Algebra, 5, French or German, 5, Mechanical Drawing, 5, English History.	Geometry (Plane), 2, French or German, 5, Descriptive Geometry, General History.	Geometry (Plane), 5, French or German, 5, Kinematic Drawing, 5, General History.
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Rhetorical work the same as other courses.

Shop work two hours each afternoon.

SOPHOMORE.

Geometry (Solid), 5, French or German, 5, Chemistry, 1, 5	Plane Trigonometry, Chemistry, 1, 5, French or German, 5.	Spherical Trigonometry and Surveying, 5, Mechanical Drawing, French or German, 5.
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Rhetorical work the same as other courses.

Shop work two hours each afternoon.

JUNIOR.

Advanced Physics, 5, Analytical Geometry, Chemistry of Metals, 5.	Advanced Physics, 5, Differential Calculus, Elements of Mechanism, 5.	Advanced Physics, 5, Integral Calculus, 5, Machine Design, 5.
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Technical reading from engineering magazines and papers once per week.

SENIOR.

English Literature, 5, Analytical Mechanics, 5, Machine Drafting, 5.	Mechanics of Materials, 5, Steam Engine, 5, Astronomy, 5.	Thermodynamics, 5, Hydraulics, 5, Thesis Work.
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Laboratory work in engineering in afternoon.

Shop work each term, during entire course, in wood shop, blacksmith shop, foundry and machine shop. Military drill each term during first two years. This course leads to B. E. A two years' graduate course leads to M. E.

B. Treasurer's Report.

UNIVERSITY OF WYOMING,
 AGRICULTURAL COLLEGE,
 LARAMIE, WYO., June 30, 1896. }

Report of treasurer of said institution to the Secretary of Agriculture and the Secretary of the Interior, of amount received under Act of Congress of August 30, 1890, in aid of colleges of agriculture and the mechanic arts, and of the disbursement thereof, to and including June 30, 1896 :

Balance on hand July 1, 1895.....	\$ 4,785 46
Date of receipt of installment for 1895-'96, August 29, 1895	21,000 00

Total available for year ending June 30, 1896.....	\$25,785 46
Disbursements thereof for and during the year ending June 30, 1896 :	

Agriculture	\$ 1,727 87
Mechanic Arts	3,216 51
English Language	3,528 55
Mathematical Science.....	1,004 76
Natural and Physical Sciences.....	7,956 08
Economic Science	5,696 36
Total expended during the year.....	\$ 23,130 13

Balance remaining unexpended July 1, 1896.....	\$ 2,655 33
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I hereby certify that the above account is correct and true, and truly represents the detail of expenditures for the period and by the institution named, and that said expenditures were applied only to instruction in agriculture, mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction.

JOHN C. DAVIS, Treasurer.

UNIVERSITY OF WYOMING.

Agricultural College Department.

SIXTH ANNUAL REPORT

. . . OF THE . . .

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

FOR THE YEAR 1896.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

BOARD OF TRUSTEES.

HON. STEPHEN W. DOWNEY, PRESIDENT, Laramie,	-	-	1897
DR. GRACE RAYMOND HEBARD, SECRETARY, Cheyenne,	-	-	1897
HON. OTTO GRAMM, Laramie,	-	-	1897
HON. MELVILLE C. BROWN, Laramie,	-	-	1897
PROF. JAMES O. CHURCHILL, Cheyenne,	-	-	1899
HON. JAMES A. McAVOY, Lander,	-	-	1899
HON. TIMOTHY F. BURKE, Cheyenne,	-	-	1901
HON. JOHN C. DAVIS, TREASURER, Rawlins,	-	-	1901
HON. CARROLL H. PARMELEE, Buffalo,	-	-	1901
STATE SUPT. OF PUBLIC INSTRUCTION ESTELLE REEL,	-	-	<i>Ex-Office</i>
PRESIDENT FRANK PIERREPONT GRAVES	-	-	<i>Ex-Office</i>

AGRICULTURAL COMMITTEE OF THE BOARD OF TRUSTEES.

OTTO GRAMM, Chairman,	-	-	-	-	-	-	LARAMIE
S. W. DOWNEY,	-	-	-	-	-	-	LARAMIE
M. C. BROWN,	-	-	-	-	-	-	LARAMIE

PRESIDENT OF THE UNIVERSITY OF WYOMING.

FRANK PIERREPONT GRAVES, A. M., PH. D., LITT. D.

STATION COUNCIL.

F. P. GRAVES, A. M., PH. D., LITT. D.,	-	-	-	-	DIRECTOR
B. C. BUFFUM, M. S., VICE DIRECTOR,	-	-	-	-	
A. NELSON, M. S., A. M.,	-	-	-	-	AGRICULTURIST AND HORTICULTURIST
E. E. SLOSSON, M. S.,	-	-	-	-	BOTANIST
W. C. KNIGHT, A. M.,	-	-	-	-	CHEMIST
C. B. RIDGAWAY, A. M.,	-	-	-	-	GEOLOGIST
G. R. HEBARD, A. M., PH. D.,	-	-	-	-	PHYSICIST AND METEOROLOGIST
	-	-	-	-	SECRETARY

SUPERINTENDENTS.

J. S. MEYER,	-	-	-	-	LANDER EXPERIMENT FARM
J. F. LEWIS,	-	-	-	-	SHERIDAN EXPERIMENT FARM
A. E. HOYT,	-	-	-	-	SUNDANCE EXPERIMENT FARM
M. R. JOHNSTON,	-	-	-	-	WHEATLAND EXPERIMENT FARM
W. H. FAIRFIELD, B. S.,	-	-	-	-	WYOMING UNIVERSITY EXPERIMENT FARM
THE HORTICULTURIST IN CHARGE,	-	-	-	-	
	-	-	-	-	WYOMING UNIVERSITY EXPERIMENT GROUNDS

SIXTH ANNUAL REPORT

. . . OF THE . . .

WYOMING AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR 1896.

I have also the honor as Director to present to you the annual report of the Agricultural Experiment Station for 1896.

The entire work of the Station is comprehended in five agricultural bulletins, a bulletin on petroleum by the geologist and chemist, published with state funds, and an index bulletin of the first twenty-nine bulletins by the secretary. The agricultural bulletins and the index are appended in full to this report. All these bulletins have been a subject of much interest and a wide distribution has been demanded. The title and an epitome of each of the agricultural bulletins are given below.

**No. 27. Meteorology for 1895 and Notes on Climate
from 1891-1896.**

This bulletin contains forty-four pages with eight figures of meteorological instruments and five tables of data for 1895. Comparative notes upon the climate of Wyoming for five years are also given from records of observations upon each of the experiment farms.

No. 28. First Report on the Flora of Wyoming.

This is an extensive publication of one hundred and seventy-four pages, with four illustrations. One illustra-

tion is a map of the state. The work of the department of botany is outlined and the flora of the different parts of the state, the mountains, the plains, the Atlantic and Pacific slopes, are compared. An annotated list of all the species collected is given, with separate lists of new species and varieties and those which have been reported by other collectors.

No. 29. Alkali, Some Observations and Experiments.

This is a thirty-six page bulletin, illustrated with six plates. It takes up the composition of alkali in Wyoming, its effect upon soil and crops, and it reports some experiments showing the effects of such salts in the soil upon seed germination and plant growth.

No. 30. Stock-Feeding Experiments at Lander.

This is a twelve page bulletin giving briefly the results in feeding steers, sheep, and lambs upon the Lander farm. It contains seven tables, giving the food eaten, the gains made, and the cost and profit with the different foods used. The feeding was done by J. S. Meyer, the superintendent, and his assistant, H. S. Kendall.

No. 31. The Worst Weeds of Wyoming and Suggested Weed Legislation.

This is a bulletin of fifty-eight pages, with fifteen illustrations of weeds. It contains descriptions of our most dangerous weeds and suggestions as to methods of exterminating them. A list of fifty of Wyoming's worst weeds is also given, and a form of law upon this subject is suggested to the legislature of Wyoming.

PLAN OF STATION WORK FOR 1896.

The following plans and instructions for experiments were carried out during the season of 1896. They were recommended by the Station Council and approved by the Agricultural Committee of the Board of Trustees.

Department of Agriculture and Horticulture.

A. GENERAL WORK FOR ALL EXPERIMENT FARMS.

1. Continuation of Special Potato Test.
2. Forage Crops.
3. Sub-soil experiment.
4. Stooling power of grains.
5. Continuation of fruit experiments.
6. Trials of novelties in vegetables and fruits.
7. Plant larger areas to alfalfa, clover and grasses to improve soil.

B. UPON THE LARAMIE FARM.

1. Inauguration of special permanent soil experiments.
2. Small plats of tame and native grasses and forage plants.
3. Growing and studying as many varieties of the small grains as we can obtain, looking toward the improvement of varieties for this region, by crossing, selection, and care.
4. Irrigation: duty of water; flooding vs. furrow or seepage irrigation for small grains. Sub-irrigation.
5. Horticulture: continuation of investigations in the green-house; floriculture for decoration of grounds; fruit and vegetable tests.

Department of Botany.

1. The preparation of a report upon the flora of Wyoming, to be based upon the collections of 1895 and earlier years.
2. Field work, having in view the following objects:
 - a. The securing of additional material of and data upon the flora of the state.
 - b. The building up of the herbarium.
 - c. The securing of information upon the extent of injury by and prevalence of injurious fungi.
 - d. Further consideration of the weed problem.
 - e. A study of and report upon the native small fruits.
 - f. A study of and report upon the native shade-trees and ornamental shrubs.
 - g. The collection of information upon our forests, looking to a report upon forestry and the lumber interests.

Department of Chemistry.

1. Composition and comparative cost of prepared cereal foods.
2. Determination of the potential energy in foods by the calorimeter.
3. Analyses of new and important forage plants.
4. Comparative analyses of irrigation and underground drainage water.
5. Analysis of aluminum ware and tests of its uses in cooking.
5. Tests of foods for adulterations.

Department of Physics.

1. Investigation of the physics of the soil.
2. Petrographic determination of the coarse admixed parts of the sand.
3. The behavior of soils toward water:
 - a. The power of retaining moisture in the soil;
 - b. The evaporating power of the soil;
 - c. The filtrating power of the soil;
 - d. The capillary action of the soil.
4. Cohesion and attraction of the soil.

Department of Meteorology.

1. Continuation of the work of making observations and co-operating with the State and United States Weather Service.
2. Observations on the precipitation from as many places in the state as possible.
3. Observations upon the direction and force of the air currents at Laramie.
4. Study of terrestrial radiation.

Stock Experiments at Lander.

The last report of the station mentioned the inauguration of feeding experiments upon the Lander Experiment Farm. Feeding sheds and yards were constructed, weighing scales and other equipment purchased for the first feeding test, which was carried out during the winter months. The results are published in bulletin No. 30. Some other work with live stock was planned, and blooded merino sheep and berkshire hogs were purchased for breeding purposes.

The largest agricultural interests in Wyoming are

centered in the stockraising industry. The work done at Lander is merely a beginning, and it is hoped may be continued. Correspondence has been carried on with the authorities at Washington in regard to the continuance of this special work at Lander. It appears that the interpretation of the law establishing and supporting experiment stations favors the expenditure of this money upon only one station in each state. However, our carrying on the stock experiments at Lander seems to have met with some favor. It is to be hoped that the general order to appropriate no part of the Hatch fund to sub-stations in the future may be so modified that we can continue experiments in both stock and fruits.

On account of the uncertainty regarding this whole matter, no further experiments in feeding can be planned and put into operation until such time as we can be sure of completing them.

REPORT OF DIRECTOR.

F. P. Graves succeeded A. A. Johnson as Director of the Agricultural Experiment Station, July 1st, 1896.

Inasmuch as circular No. 29 of the Department of Agriculture, Office of Experiment Stations, looked toward the abandonment of all sub-stations and made an immediate inspection of the sub-stations desirable, the new director visited all of them at the following dates:

Lander farm, August 14th,
Saratoga farm, August 18th,
Sundance farm, September 11th,
Sheridan farm, September 13th,
Wheatland farm, October 13th.

The Saratoga farm proved to have been abandoned some time ago for lack of irrigation, but all the other substations seemed in a prosperous condition. While acquiescing in all orders from the authorities at Washington, the director ventures to hope that the station will be allowed to continue at least one or two farms. On account of the widely differing altitudes in Wyoming, two farms at least, beside the home station, are necessary to illustrate thoroughly what should be done by the farmers of the state.

The Lander and Sheridan farms were especially well conducted. Messrs. Meyer and Lewis seem to take great interest in their work, and to be model superintendents in every way. The stooling test and other experiments in grain were successfully conducted at Lander, and the fruits, small and large, were a credit to the station. In spite of the trouble he has had to reclaim his land, Mr. Lewis at Sheridan had the finest display of alfalfa, grains, melons, and tomatoes in the state. Supt. Lewis sees to everything personally and has built up a farm that attracts scores of visitors. The Wheatland farm, under the supervision of Mr. Johnston, has been very successful in fruit raising. The farm at Sundance is the only one carried on without irrigation.

TREASURER'S REPORT.

WYOMING AGRICULTURAL EXPERIMENT STATION,

LARAMIE, WYOMING,

—IN ACCOUNT WITH—

THE UNITED STATES APPROPRIATION, 1896.

DR.

To Receipts from the Treasurer of the United States,
as per appropriation for the fiscal year ending
June 30, 1896, as per Act of Congress approved
March 2, 1887.....

\$15,000 00

CR.

By Salaries.....	\$ 4,604 67
Labor.....	5,819 12
Publications.....	1,010 18
Postage and Stationery.....	167 12
Freight and Express.....	197 55
Heat, Light, and Water.....	68 01
Chemical Supplies.....	142 83
Seeds, Plants, and Sundry Supplies.....	352 21
Feeding Stuffs.....	229 74
Tools, Implements, and Machinery.....	471 88
Furniture and Fixtures.....	164 40
Scientific Apparatus.....	126 00
Traveling Expenses.....	765 81
Contingent Expenses.....	8 10
Building and Repair.....	454 38
Live Stock.....	418 00
Balance.....	

\$15,000 00 \$15,000 00

We, the undersigned, duly appointed auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1896; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the United States are shown to have been \$15,000.00, and the corresponding disbursements \$15,000.00, for all of which proper vouchers are on file and have been

by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

[SEAL.] [Signed] C. H. PARMELEE,
OTTO GRAMM,
JAMES A. McAVOY,

ATTEST: Auditors.
GRACE RAYMOND HEBARD,
Custodian.

SUPPLEMENTARY STATEMENT.

DR.

To Receipts from sale of Farm Products.....	\$266.95	\$266.95
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CR.

By Traveling Expenses	\$266.95	\$266.95
Balance.....	_____	

REPORT OF THE AGRICULTURIST AND HORTICULTURIST.

Each year of the Station's existence shows more accomplished than did the preceding. Our lines of work for 1896 have been more varied than heretofore. The special experiments have been the "Potato Test," the "Stooling Test," the stock feeding experiments at Lander, and the Alkali experiments. The first two mentioned were carried on under like instructions upon each of our experiment farms. This, being the third year of the potato test, completes the experiments as planned. A large amount of material relating to the test is on hand for publication. The stooling test is also finished and com-

pletes the co-operative work upon the different farms as planned.

Our horticultural work with both large and small fruits has been especially successful upon the Lander Farm, and with small fruits upon the Sheridan Farm. The orchard trees upon the Wheatland Farm have suffered no calamities since they were planted, but the orchard upon the Sheridan Farm was annihilated last winter by the unfavorable climatic conditions. We now have sufficient notes upon small fruits for a bulletin.

At the home station we have given more attention than in any previous year to grasses and forage plants, and small grains. The scope of the work upon the Laramie Farm is indicated in the report upon this farm by Mr. W. H. Fairfield. The Agricultural Committee of the Board of Trustees made Mr. Fairfield superintendent of the Laramie Farm, in June. This enabled the agriculturist to turn over to him many of the details of the farm work. He has also had direct charge of the daily records and crop notes, at the same time assisting in the general work of the department in a most efficient and faithful manner. The field notes taken this season will exceed by fully one-half those of last year. This year's crop report for the Laramie Farm alone will cover over 260 pages of foolscap. The records from the sub-farms are also quite extensive, and putting this mass of material into useful form by computing results and by collation, classification, and preparation for publication requires a large amount of routine work.

Some special work with alkali was planned last year. Experiments were carried on in the greenhouse last win-

ter, and the results were published in bulletin No. 29, last June.

The first experiments with live stock by this station were in feeding steers and sheep upon the Lander Farm. The feeding was done during January, February, and March, and the results were published in bulletin No. 30.

The improvements made upon the farms are indicated in the reports of the superintendents. The office of the experiment station was moved from room 32 in the basement to room 7 on the first floor, and the agricultural museum was moved from the same room to a room on the third floor. This gives a comfortable and roomy office near that of the President and Director. Putting the museum into another room is also of great advantage, as it will enable the agriculturist and his assistant to do much of their indoor work with grains and other crops there, thus doing away with the accumulation of bulky and unsightly material, dust, and litter in the office.

In accordance with the suggestion of Director True, in addition to our regular soil records, the station has organized a permanent line of soil experiments. The agriculturist will attempt to test the lasting qualities of our soil with only ordinary cultivation and irrigation. Other soil investigations being made by this department are, the effects of rotation, planting of nitrogen gatherers, green manuring, fertilizing with manure, irrigation and cropping for alkali soil, sub-plowing, and sub-irrigation.

The greenhouse was used during the early spring months for the alkali experiment above referred to. Several thousand plants were also raised from slips and seeds, with which the campus was beautified during the summer. The greenhouse is now practically full of plants which are being grown for planting out next season.

In addition to the regular work, the agriculturist has investigated some stock troubles in the state. Some bacteriological work is still in progress with anthrax of sheep which is believed to have broken out upon the Laramie Plains. Tuberculosis in the human subject has also been demonstrated.

A new tick infesting the ears of stock was brought to notice two years ago and is still under consideration.

The agriculturist collected a large number of insects this season. At present our cases for insects are full to overflowing.

The correspondence of the office has steadily increased, showing a healthy growth in the interest of the Wyoming farmers in the station work.

This year marks the first farmers' institute work. It began in a small way at Lander. This is an important step in the agriculture of the state and is important to the station, since through such institutes the station workers learn the needs of the farmers, and the farmers get the benefit of our experimentation more directly.

The several superintendents of the experiment farms have done everything possible to bring about the best results in the work this year, and thanks are hereby extended to each for his hearty co-operation.

REPORT OF THE BOTANIST.

The year has been a very busy one, and, although something has been accomplished, much still remains to be done.

The early months were devoted to the determination and distribution of such of the material from the collec-

tions of 1895 as had not yet been worked. Following that, preparation of a report upon the flora of the state as represented by the collections up to date, was undertaken. This proved to be a task of no small magnitude, but after some months of unremitting labor, said report was published about June 1, as bulletin No. 28.

The report occupied about 176 pages and enumerated 1,176 species, with notes and data upon each, as represented in our collections. Besides these, 184 were enumerated as recorded from this state by other collectors, making a total of 1,360 at that time. Of these four were described and published as new species and eleven as new varieties. As said report becomes a part of the Annual Report of the Agricultural College, further reference to it is unnecessary.

Knowing that our herbarium yet lacked much of containing the complete flora of the state, field work has again occupied a large part of the past summer months. The main purpose of the field work was to secure material of plants new to our collection, but incidentally a large amount of duplicate material was secured for exchange.

Three expeditions were carried out, viz: One covering five weeks, during which collections were made in Crook, Sheridan, Weston, Converse, and Laramie counties; one covering fifteen days in the mountains of southwestern Albany county; and one of a few days in northern Laramie county. The making of these collections necessitated nearly 1,600 miles of travel by rail, 184 by stage, and about 275 with camp outfit, not counting the trips that were made at various times during the season in the vicinity of Laramie and in the Laramie Hills.

Altogether, during the season, there were collected in duplicate (approximately ten sheets of each) about 950 numbers or between 9,000 and 10,000 sheets of plants. Only about one-half of this material has been worked as yet, but enough has been done to show that a large number of species has been added to the collection both of seed and spore producing plants. Some of these, it seems probable, will prove new to science.

Visits were made in July and August to the Sundance, the Sheridan, the Wheatland, and the Laramie Experiment Farms. Special observations were made at each of these places in regard to the prevalence of fungus diseases of the several crops. It is my pleasure to report again that so far, at least, we are remarkably immune from all fungi except those forms which vegetate in the tissues of the host during the entire period of the host's development; as, for example, the smuts.

Data are being collected upon the native fungi, and among those observed may be mentioned the Black Knot of Plum and Cherry. This was found in abundance on the native species in Sheridan county, near Parkman. Thus far no injury from this disease has been reported from any part of the state.

For several years data upon the weeds of the state have been sought. Particularly during the past season have such facts concerning the prevalence of noxious weeds come to hand from personal observation as to demand a bulletin upon this subject. Said bulletin has just been published as No. 31. For list of weeds described and illustrated, reference is made to the bulletin as incorporated in the Annual Report.

For the improvement of the herbarium, a number of

exchanges are being carried out, which, with the work yet to be done upon the year's collections, will occupy some time.

As fast as may be, data are being secured upon the ornamental trees and shrubs of the state; the native small fruits; and upon the forests and forest conditions in Wyoming. The collection of data upon and specimens representing our flora will, of course, continue with a view of making our collection as complete as possible.

The correspondence of the department is constantly increasing, letters on various botanical subjects such as weeds and the determination of other plants being frequently received. These all receive prompt attention and the best information at hand on the subject of the inquiry.

REPORT OF THE CHEMIST.

The study of the effects of irrigation on the amount and position of the alkali in the soil has been continued during the past year. Samples of alkali have been collected from different parts of the state and soil samples taken from the Laramie Farm at different depths before and after irrigation. The movement of water in the soil under irrigation is also being investigated, in order to determine the best methods of preventing the rise of the alkali. The total amount of the alkali salts in the soil of the Laramie Farm is very small, not more than is desirable, yet in the five years the land has been irrigated, the alkali has risen so as to encrust the surface in some places and destroy crops.

Analyses have been made of all the prepared cereal

foods sold in the Laramie and Cheyenne markets, and will be published soon in a bulletin, together with calorimetric determinations and tests of digestibility.

REPORT OF THE GEOLOGIST.

Work has been continued along three lines of investigation during the year, but sufficient data has not been secured to publish in the form of a bulletin. Owing to the great distances one has to go by wagon while traveling in the state, a season's work is not so extensive as might be anticipated.

During the past season the following subjects have been studied:

Wind Erosion.

Soil formation and Geological Study of Rocks entering into soil.

Artesian Basins in the State.

Since there is much valuable land in Wyoming that is not watered by nature, and there are no streams from which to irrigate, it has been thought best to make a careful survey of the state to determine the location of artesian basins so that the station may recommend the drilling of wells in such places in order to furnish water for irrigation.

This work has been carried on in the following localities: The east end of Freezeout Hills in Carbon county; along the south slope of the Seminoe Mountains; in Laramie county, along the foot of the Laramie Mountains, extending from the Big Laramie river to the west line of the county; in Sweetwater county, from six miles north of Green River to twenty miles below; in Fremont county,

along the foot of the Wind River Mountains, and from Hailey northwest to Fort Washakie.

This work is now about one-half completed, and will be finished as soon as possible.

The geologist and chemist for the last three years have paid considerable attention to the occurrence of petroleum in Wyoming. Samples of the petroleum were collected at various times prior to 1895, and in the fall of 1895 a thorough study of the separate oil districts was commenced. The Salt Creek Oil Basin being the one of greatest importance in the state, since it is producing oil commercially, was the first one studied, and the Geology, Technology, and Analysis of the oil was issued in bulletin No. 1 of the Petroleum Series, in June, 1896. In the fall of 1896 a geological examination of the Popo Agie, Lander, and Shoshone Oil Districts was made. This work, when completed, will constitute bulletin No. 2 of the Petroleum Series, and will be finished at the close of 1896, or in January, 1897. It is expected that the work will be continued and that each oil district in the state will receive similar attention, and the results will be published in bulletin form, giving brief descriptions of the district and oil, and also the results of distillation and analyses.

REPORT OF PHYSICIST.

The present physicist was appointed June 12, 1896. He entered upon his duties July 1st, and immediately began preparation for the physical analysis of the thirty-six soil samples which had been collected by the agriculturist during the year 1895.

The method used during the past summer was

Osborne's beaker method, described in bulletin No. 4, U. S. Department of Agriculture, Division of Agricultural Soils. The results are to be confirmed by the use of Prof. Hilgard's soil elutriator.

Coming to the duties so late in the year, the physicist was unable to determine the quantity of moisture in the soil in the field, but hopes this next season to make a thorough investigation of this important subject.

The following are some of the physical properties of the soils which are being examined as rapidly as circumstances will permit:

1. State of division.
2. Absorbent power of soils for gases.
3. Behavior of soil towards water.
4. Relation to heat.
5. Capillary power.
6. Cohesion and adhesion of the soil.

REPORT OF THE METEOROLOGIST.

The meteorological observations made during the present year have been similar to those of previous years. The equipment of the station consists of a complete set of instruments for obtaining the relative humidity, maximum and minimum temperature, pressure of the air, rainfall, snowfall, velocity and direction of the wind, evaporation, percentage of sunshine, and temperature of the soil at various depths. The velocity and direction of the wind is recorded by a self-registering apparatus, operated by an electric battery. All observations, excepting those that are self-registering, are taken at 7 a. m. and 7 p. m.

In addition to the records made at Laramie, the max-

imum and minimum temperature, precipitation of rain and snow, and the percentage of sunshine have been recorded at the five Experiment Farms, and many volunteer observers throughout the state have co-operated with us in making monthly reports of the amount of precipitation and temperature in their respective localities.

The next bulletin to be issued from the Meteorological Department will be on the amount of sunshine throughout the state as compared with the total possible amount.

REPORT FOR THE LARAMIE EXPERIMENT FARM.

W. H. FAIRFIELD, SUPERINTENDENT.

The general plans for this season's work have been fully carried out. The Agriculturist's duties, fortunately, did not call him away from Laramie during the summer, so our notes and observations upon the various crops are quite exhaustive.

The season proved to be an average one, and our results are very satisfactory.

The three years' test with potatoes was concluded. Work with various forage crops was continued and their growth and habits carefully observed. The amount of water used in irrigating the different crops was measured as accurately as possible. Work in sub-irrigation was continued. The test of the stooling power of grain planted at different distances apart has furnished some interesting data.

The new lines of investigation begun this season, which are to continue year after year, have been carried on successfully. In commencing the special study and work on the varieties of cereals best adapted to our condi-

tions, seed of 613 varieties were obtained. Out of this number, 506 matured seed and were harvested. Notes were kept for each individually.

In the sub-soil tests, wheat, barley, oats, turnips, beets, and potatoes were tried with varying results.

An acre plat was set aside for the permanent soil tests, one half being seeded with wheat, the other half with oats.

The usual amount of work was accomplished with general farm and garden crops. The total number of varieties planted and the different treatments given, with the different conditions under which the same varieties were planted, reached one thousand, requiring this number of entries in the crop report. Of this number 804 matured and were harvested.

Some much needed permanent improvements were made on the farm, consisting of a shed for the shelter of tools, and a small root cellar. Some necessary machinery was procured from the abandoned experiment farm at Saratoga, including a mowing machine, horse rake, potato digger, and plows, cultivators, etc. A light buggy and a one-horse thresher and tread-power were purchased.

These valuable additions to our equipment will enable us to do more and better work than was possible in the past.

The work on the farm is closed; but it will take the entire winter to get the notes recorded in permanent form and the yields computed.

REPORT OF THE LANDER FARM.

J. S. MEYER, SUPERINTENDENT.

I herewith submit the annual report of the Lander Experiment Farm for the year 1896.

The season, with the exception of a cold June, has been a favorable one, with more moisture than usual, particularly during July and August. First killing frost, September 27th.

Small grains have done well, the yields being rather above the average of former years. Forage crops were very successful, especially alfalfa. The new ground, about eighteen acres, and five of the old acre plats, that were seeded to alfalfa this spring, have made a fine growth, and as there is a good stand will undoubtedly make a good yield next season.

Half an acre each of orchard grass, red clover, rye grass, and sanfoin were sown, made a good growth, and have a fairly good stand.

The new forage plant, Australian salt bush, which was recommended so highly for alkali lands, has done best where the soil is not so strong with alkali, though the roots may spread another year and cover the ground where it is crusted with alkali. It has made a growth of twelve inches this year from the seed.

The flat pea (*Lathyrus sylvestris*) was transplanted this spring and made a good growth, but the vines kept to the ground so close that it could not be mown to any advantage. As I understand this plant is not expected to be of any value until the third year, we can expect no record of its hay value this year.

The farm now has some 26 acres seeded to grasses,

mostly alfalfa, with a mixture of timothy. Amount of seed used per acre this season, alfalfa, 18 pounds; timothy, 3 pounds.

The small grain stooling experiment was successful, both as to stools and yields.

On the sub-soil plat, crops yielded best on the half not sub-soiled.

All root crops have done well, and the twenty new varieties of potatoes, one pound each, sent us from the Laramie farm this season, have nearly all made good records.

Garden vegetables, with a few exceptions, have done well.

The effect of the freeze of September, 1895, is very apparent in the orchard, fully 75 per cent of the trees having been killed. This is not altogether a total loss, as a large number have started growth above the graft, and in a few years will be as good as when killed. A few apples of the following varieties matured: Wealthy Yellow Transparent and Tetofsky.

The canes and vines of the small fruits, including grapes, made an excellent growth this season, but owing to the freeze of last September (1895), last year's canes fruited very little—not enough for record. A few nice bunches of the following varieties of grapes ripened this season: Concord, Wyoming Red, and Delaware.

The nursery stock set out in the spring of 1895 suffered severely in the September freeze of that year, nearly all of it killing down to the snow. As this covered the graft, there is no material loss beyond that of one year's growth. This season's growth has been stronger and thriftier than last.

Of the live stock, the sheep purchased for the farm have done well, each of the ewes having a fine lamb.

The trio of blooded berkshire hogs bought in the spring have made no increase as yet, but have thrived and are in fine condition.

It has been suggested by some of our citizens that from now on the Lander farm could better serve their interests by continuing the horticultural work and stock-feeding experiments.

As will be seen by bulletin No. 30, we made a fairly successful experiment last winter in marketing our crop by feeding it to stock, and there is no doubt that further experiments will fully demonstrate that the most profitable way for our citizens to market their crops will be in feeding them to stock.

I would recommend that more of the plats be seeded to alfalfa next season.

The sales on the farm are small, as the crops are now used for the farm stock.

REPORT OF THE SUNDANCE FARM.

A. E. HOYT, SUPERINTENDENT.

In accordance with custom, I transmit herewith the Annual Crop report, together with the permanent Crop Record and Field Notes, of the Sundance Experiment Farm for the season of 1896.

The total precipitation for the four months of April, May, June, and July was 10.39 inches, distributed as follows: April 2.51, May 2.05, June, 3.45, July 2.38.

The mean average temperature for the four months
—(c)

referred to was as follows: April 39.9, May 52.2, June 60.8, July 67.5.

Hailstorms and excessive rains during the growing season caused the almost total destruction of all small grain on the farm, although it is worthy of note that the past season is the only one in its history when the farm was similarly troubled. Fortunately, that part of the farm devoted to the stooling test with small grain, escaped uninjured, and the test was carefully and accurately made. It is valuable as showing that the best results and largest yields were produced from seeds planted farthest apart.

Complete and detailed comparative tests in sub-soiling were conducted, as per instructions, in small grains, potatoes, corn, and beets. Best results were obtained from sub-soiled ground in all cases except small grain.

It was not possible to reach a conclusion on the smut test of small grain planted in the fall, which was referred to in my annual report of 1895, owing to the destruction of the grain by hail.

Fruit trees made a large, thrifty growth—the plum producing considerable fruit.

Small fruits passed through the winter unharmed, and promised a most prolific yield, but this was not realized owing to the excessive storms.

Corn matured fully, and showed an excellent quality, especially in sub-soiled ground.

Among the new grasses planted during the season are: Fall Meadow Oat Grass, Italian Rye, Meadow Fescue, Alsike Clover, English Rye, and Mammoth Red Clover. All sprouted promptly, and attained a good height before the close of the growing season.

Of the forage plants the flat pea proved the best.

Of the grasses experimented with since the establishment of the farm, the Brome Grass has proved incomparably the best of all. Much of the seed has been distributed among the farmers of the county, who report that it is a success wherever tried.

A sub-soil plow was added to the farm machinery during the year.

Farmers of the county show a constantly increasing interest in the work of the farm, and a more thorough appreciation of the benefits derived from a close study of its workings, and from the results of experiments conducted. In addition to the seed distribution, much small fruit, and shrubbery has been taken from the farm and transplanted in various parts of the county, with uniformly good results.

REPORT OF THE WHEATLAND EXPERIMENT FARM.

M. R. JOHNSTON, SUPERINTENDENT.

I herewith submit the report of the Wheatland Experiment Farm for the season of 1896.

Work was begun on March 15th, under the most favorable conditions, the soil being in good shape, and containing plenty of moisture to bring up crops. The outlook during the fore part of the season for all kinds of grain and fruit was very promising, but later, owing to a combination of circumstances, such as drouth occurring in latter part of April and fore part of May, a shortage of water for irrigation purposes and a hailstorm, crops of all kinds were badly damaged. The fruits, for which the prospect of a good yield was very flattering, were totally destroyed by the hail. The small grain recovered some-

what and made from one-fourth to three-fourths of an average crop. Corn and potatoes, considering the shortage of water, made fair crops. Taking them as a whole, the results this season have not been very satisfactory, as they are considerably below the average.

The farm work closed on October 31st. The farm tools and machinery of all kinds were cleaned and stored away. They are all in fair condition, considering the usage they have had. Buildings, fences, and bridges are all in good state of repair, and the fruit and forest trees have gone into the winter in excellent condition.

REPORT OF THE SHERIDAN FARM.

J. F. LEWIS, SUPERINTENDENT.

The spring was somewhat backward, opening about two weeks later than usual. The weather was hot and dry during July and August, with a scarcity of irrigation water, but by irrigating those crops first which would ripen first, none were allowed to burn or become injured to any great extent. Grains planted on sod ground suffered the most. The first killing frosts in the fall did not occur till September 19 and 25. This allowed peanuts, melons, tomatoes, and other vegetables to fully mature.

The plans for the year have been fully carried out. The potato test did not give as good results as heretofore, as the crop was a poor one. The potatoes in this county which were planted early and watered when both the ground and the water were very warm, seemed to blight badly. The Australian salt bush has succeeded finely upon our worst alkali ground. The plants have nearly

covered the ground even where no weeds would grow, and should it live through the winter it may prove of value for such land. Flat pea has made good crops, but as yet I have failed to find any animal which will either graze on it or eat the cured hay. The experiments on the stooling power of grains and upon sub-soiling have both been carried out successfully. Three additional acre plats were laid out, broken, and planted to grain this season.

Improvements made upon the farm were some bridges over ditches, plastering the new cellar both inside and out, and the construction of additional drains through the alkali ground. One hundred rods of new drain ditch were made, twenty rods of the old ditch deepened, and a ditch opened across the south end of plats 1 to 4 to catch waste water which runs from the adjoining farm.

The rains of August, 1895, raised the sap in our trees and the severe freeze following in September killed our orchard of apples, plums, and cherries. The nursery stock was killed down to the ground, but much of it came up again from above the graft and has made fine growth this season. One-fourth of an acre was set to raspberries, blackberries, and gooseberries, and one-half acre to strawberries. Five of our strawberry growers wish this farm to test the length of time a strawberry bed will produce a paying crop. For this purpose I have left twenty-two rows of the old bed, plowing up the rest after the new bed was set. All our small fruits and nursery stock were well wooded and went into the winter in the best possible condition.

The land of the Sheridan farm is in better condition than at any former time. The dry season, together with our drain ditches, has prevented alkali deposit, and the

ground is in a better state of tilth. The farm has been kept clean and there are fewer weed seeds in the soil than ever before.

Our farmers and business men take more interest in the farm each year. This season I have had several hundred visitors. Our own citizens as well as strangers come here to see what can be grown in this county, as well as for general information. This farm is doing great good to this community and the state.



UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

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JULY, 1896.

Indexing the First Twenty-Six Bulletins of the Station.

BY THE SECRETARY.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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* " No. 3—November, 1891. The Sugar Beet in Wyoming. D. McLaren, Agriculturist, and E. E. Slosson, Chemist.

* " No. 4—December, 1891. Meteorology for 1891. B. C. Buffum, Meteorologist.

FIRST ANNUAL REPORT, 1891.

General Statement Regarding Station Work, with Bulletins Nos. 1 to 4, inclusive. D. McLaren, Director.

BULLETIN No. 5—February, 1892 Best Varieties and Breeds for Wyoming. D. McLaren, Agriculturist, and B. C. Buffum, Horticulturist.

† " No. 6—May, 1892. Soils of the Agricultural Experiment Farms. Relation of Geology and the Chemistry of Soils to Agriculture; J. D. Conley, Geologist. Analysis of the Soils of Wyoming Experiment Station Farms; E. E. Slosson, Chemist.

" No. 7—July, 1892. Insecticides. F. J. Niswander, Entomologist.

† " No. 8—October, 1892. Irrigation and Duty of Water. B. C. Buffum, Horticulturist.

†BULLETIN No. 9—December, 1892. Sugar Beets in Wyoming in 1892. E. E. Slosson, Chemist.

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†SECOND ANNUAL REPORT, 1892.

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BULLETIN No. 11—February, 1893. Crop Report for 1892. A. A. Johnson, Director, and F. J. Niswander, Superintendent Laramie Farm.

" No. 12—April, 1893. Ground Squirrels (Gophers). F. J. Niswander, Entomologist.

† " No. 13—July, 1893. The Feeding and Management of Cattle. W. A. Henry, Ph. D., University of Wisconsin. (Reprint by permission).

" No. 14—October, 1893. Geology of the Wyoming Experiment Farms, and Notes on the Mineral Resources of the State. W. C. Knight, Geologist.

" No. 15—December, 1893. The Winter-Killing of Trees and Shrubs. Aven Nelson, Botanist.

" No. 16—December, 1893. Grasses and Forage Plants. B. C. Buffum, Horticulturist.

†THIRD ANNUAL REPORT, 1893.

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BULLETIN No. 17—March, 1894. I. Crop Report for 1893. II. Cost and Profit of Growing Wheat. III. Sugar Beets. IV. Garden Vegetables and Tobacco. V. Meteorology for 1893. B. C. Buffum, Horticulturist, and E. E. Slosson, Chemist.

" No. 18—June, 1894. I. Reclamation of Arid Lands. II. The Harvey Water Motor. A. A. Johnson, Director.

" No. 19—September, 1894. Squirrel-Tail Grass (Fox-Tail); One of the Stock Pests of Wyoming. Aven Nelson, Botanist.

" No. 20—October, 1894. The Artesian Wells of Southern Wyoming. J. D. Conley, Physicist.

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“ **No. 23**—May, 1895. Notes on Climate. J. D. Conley, Meteorologist.

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“ **No. 25**—November, 1895. Results of Three Years' Experiments in Cost and Profit of Growing Wheat. B. C. Buffum, Agriculturist.

“ **No. 26**—December, 1895. Garden Peas. B. C. Buffum, Agriculturist and Horticulturist.

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*Out of print.
†Supply limited.

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UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 27.

MARCH, 1896.

METEOROLOGY FOR 1895,

AND

NOTES ON CLIMATE FROM 1891-1896.

BY THE METEOROLOGIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING

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METEOROLOGY FOR 1895,

AND

NOTES ON CLIMATE FROM 1891-1896.

BY L. D. CONLEY.

The Experiment Station commenced its meteorological observations in the early part of 1891, and has issued a report each year, the first one being quite extensive, figuring most of the apparatus used in the department, and explaining its use. After the first Bulletin, this, the fifth report, seems of the greatest importance, since we have sufficient data to make an intelligent comparison and formulate for all practical purposes a general idea of the climatology of the various regions of the State, from which we have observations reported to us monthly. While it takes 20 years, or more, to establish accurate scientific data as to the climatology of any region, yet the careful comparison of the observations of temperature, rainfall, directions and velocity of the wind, etc., will give so near the normal conditions in these respects, that one will be enabled to form an intelligent opinion of the climatology of the northern, eastern, central and southern portions of our State, the regions from which we have had regular reports for the past five years.

There is such a close relation existing between crops and climate and soil, that the Meteorology and Soil Physics come under the Weather Division of the Agricultural Department of the Government.

The study of Meteorology does not consist of comparing dry tables of facts and statistics, but the study of such authors as Flammarion on the Atmosphere, and Ferrel on the Winds, is as interesting, instructive and fascinating as our most popular literary works, even from a rhetorical standpoint. Davis' Elementary Meteorology, American Weather by General Greeley, Climatology and Time, and Climate and Cosmology by Croll, show what rich fields of thought and depth of research the Science has investigated, and is still pursuing. We can hardly estimate the great advantages of the Signal Stations scattered throughout the country, giving to the farmer, the shipper, and to the community at large, due warning of approaching storms and cold waves, so that preparation can be made for their reception.

We have suggested that there is a close relation existing between Climatology and crops. The experiments on our farm at Laramie (altitude 7,200 feet, the highest altitude of all the Experiment Stations of the United States) together with the weather reports, form rather an unique experiment in itself, among the group of Stations. One studying the weather report alone, would predict a poor crop; but our Museum in the Agricultural Department of the University has as fine a display of cereals and root crops from the Laramie plains, as can be produced in the United States. The fact has been established that the nights are too cold during July and August for corn, yet roasting ears have been grown at Laramie.

But our Museum illustrates to the world what can be done in the way of agricultural products, and the study of our Annual Crop Reports illustrates the wonderful influence of the weather over the crop reports for the various

seasons, the crops varying with the fluctuations of the weather.

The automatic apparatus that we have added to the department within the past two years for recording the directions and velocity of the wind is of such excellence and interest that we give herewith a cut and description. The first Bulletin issued on Meteorology was in 1891, in which were figured most of the instruments used for taking observations. That issue being nearly exhausted, it is thought best to give the figures in this issue, together with the interesting apparatus that has been added since 1891.

We feel that a few general remarks in regard to the weather will not be out of place here, for this Bulletin will fall into the hands of many who have not lived in an arid region, and in reading the tables in regard to climate, rainfall, velocity of the wind, etc., will form an absurd idea as to the real conditions of the weather as experienced by the inhabitants of such regions.

The statement is not too strong when we say that the climate of June, July and August is the most delightful of any region in the United States.

While our Winter temperature will average a little colder than that of New England, New York and Illinois, yet the high altitude and the consequent rareness and dryness of the atmosphere more than counterbalance the difference in temperature. While the weather is from 10 to 20 degrees colder here in the winter than in the above named States, yet it feels much warmer.

It is the unanimous verdict of persons who have come from said regions that our winters are much pleasanter,

due to the dryness of the atmosphere, and that our winters seem much warmer.

On the very coldest days the atmosphere is still and dry and clear. But when there is an east wind, laden with moisture, it is apparently from 10 to 20 degrees colder than the real temperature indicates.

In order to predict what the weather is going to be, even within twenty-four hours, the following data is essential—whether the barometer is rising or falling, the temperature, the dew point, the relative humidity, and the direction of the wind. These facts will enable a careful observer to foretell with a considerable degree of certainty what will be the condition of the weather for several hours in advance.

We insert some simple and general laws in regard to the movements of the barometer:

The barometer is high when the air is cold, and when the air is dry.

The barometer is high when the lower stratum of air is heated, when the air is damp, when the air has an upper movement.

We therefore observe that the rising and falling of the barometer alone is not sufficient data from which to foretell the conditions of the weather.

The following taken from the United States Department of Agriculture Weather Bureau, under "Instructions for Voluntary Observers," is of such general practical value that we publish it here, hoping that some observers will volunteer to send us information in regard to some, if not all, the questions asked. All of the points are of great importance in working out the problem of the agricultural possibilities of our new commonwealth.

GENERAL PHENOMENA OF CLIMATE.

Information of a general character relating to the growth of plants will be of value in compiling the Climatology of a district. It is suggested that where voluntary observers can do so, the following be included in their records:

Time of plowing in the spring.

Time of planting various crops.

Time of appearance of same above ground.

Time of flowering of strawberries, currants, raspberries, apples, plums, and other fruit.

Time of commencement of haying.

Time of commencement of harvesting the various cereals.

Time of ripening of various fruits.

Time of first killing frost in the fall.

Time of last killing frost in the spring.

Time of sowing fall wheat.

Time of appearance of earliest shoots of same above ground.

Time of last snow on the ground.

The depth of snow on the ground on the last day of each winter month.

The time of migration of wild fowls and birds, the flights north and south.

The time of leafing and fall of leaves in deciduous forests.

The date of breaking up of ice in large rivers; in bays.

The date of greatest rise and lowest water in important streams.

Voluntary observers are requested to include in their

monthly reports all reliable information relative to the destruction of life and property, coming to their knowledge, due to the storms, classifying it, as far as possible, as indicated in the following, viz:

Date of storm, nature of storm (tornado, northeast gale, etc.), section of country traversed by the storm; number and names of persons killed; number and names of persons injured; number of houses, barns and other buildings destroyed or damaged, with estimated amount of loss; estimated amount of damage to property; number of animals killed and estimated value.

A tornado has never been known in Wyoming, and from the physical conditions which produce them it is probable they never will be. Their origin is to the east of us. While our records show sometimes a high velocity of the wind, still there is hardly ever any damage produced by it, on account of the extreme lightness of the atmosphere, the pressure at Laramie being 11.3 pounds, against 14.7 pounds at sea level.

The wind moving at the rate of 36 miles per hour at Laramie has less than three-fourths the force or power of the wind moving at the same rate at the level of the sea.

INSTRUMENTS USED.

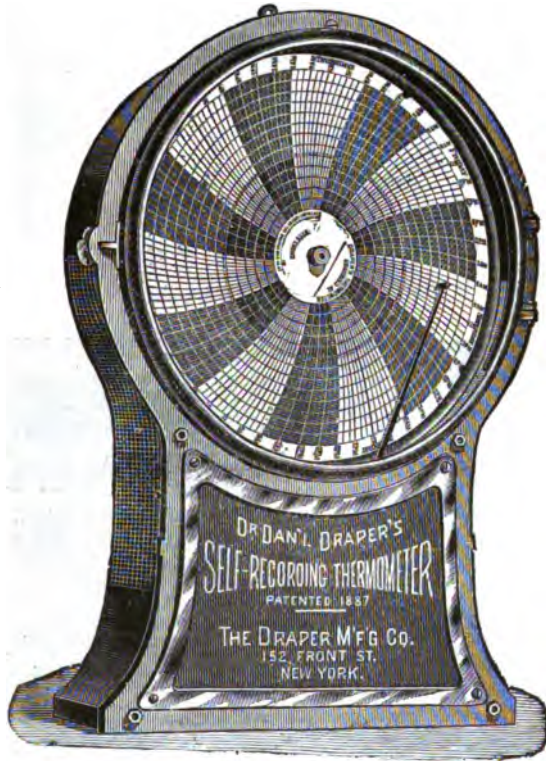


FIG. 1.—Draper's Self-Recording Thermometer.

This instrument records the temperature by means of clock-work, on large paper dials which are kept on file so that we can see the slight or sudden changes for every minute of the day. While its readings do not agree exactly with the thermometers, yet by comparing the self-registering with the observations taken by the other thermometers, we



FIG. 2.—Standard Barometer.

can find within a degree Fahrenheit the temperature for any hour of the day for the last five years.

The readings from the Standard Barometer (Fig. 2) are taken twice each day, viz., at 7 a. m. and 7 p. m. The average monthly readings are found in Table IV.

Besides this barometer we have the Richards Self-Registering Aneroid Barometer.

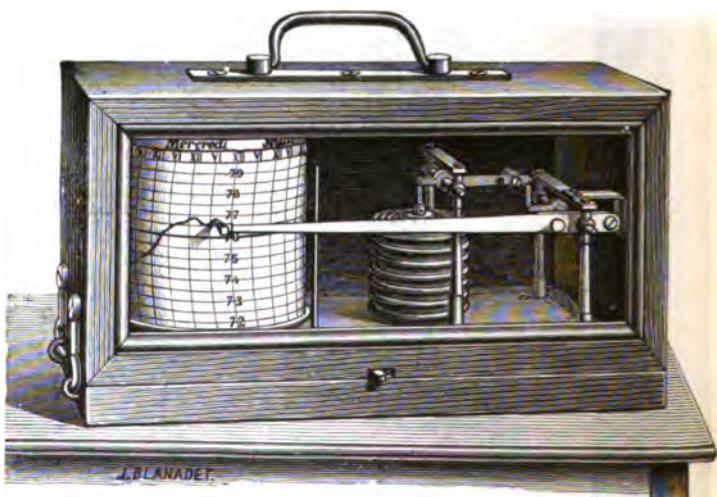


FIG. 3.—Richards' Self-Registering Aneroid Barometer.

While this instrument, like the Draper's Self-Recording Thermometer, is not as accurate as the standard instruments, yet it has the advantage of recording the barometric reading of every minute of the day, so that one can see just the time of any change; which, on being compared with the standard barometer, gives close approximate results.



FIG. 4.—Robinson's Anemometer.

This instrument is of such great importance that a more detailed account of it is given than of the others thus far mentioned.

The following description is taken from Bulletin No. 4 of this Station, on Meteorology :

“Robinson's Anemometer is an instrument designed to measure the number of miles and the velocity of the wind. The size of the cups and the length of the arms are such that three miles of wind passing causes the center of the cups to travel one mile. This ratio varies with

the velocity of the wind. According to Greeley, at great velocities it is less than three to one, and more wind is registered than really blows. This is probably true at this place, where we have so much wind, though the error is not likely to be more than 15 or 20 per cent at any time. It is also possible that there is an error due to elevation, the air here being more rarefied and consequently exerting less pressure on the vanes; its amount could only be determined by experiment. It would tend, however, to counterbalance the former error. The vanes and cross-bars are of aluminum, which gives lightness and durability. These are connected with a rod and endless screw to the cog wheels which turn the dial."

The anemometer and wind vane are on a steel tower 70 feet high, and 300 feet away from the University, connected by means of insulated copper wires with the self-registering apparatus, a description of which is as follows:

THE QUADRUPLE REGISTER.

This self-registering apparatus, made by Julien P. Friez, of Baltimore, is the most interesting instrument in the Meteorological Department. It consists principally of a fine eight-day clock that revolves a brass drum six inches long and five inches in diameter, around which a blank register is wound. As the name quadruple signifies, it is constructed to register four different measurements at once, viz.: The velocity of the wind; the direction, whether north, south, east or west; it will also record the percentage of sunshine and the amount of rainfall.

The necessary attachments for sunshine and rainfall have not been secured yet. We use it for the velocity and the direction of the wind, but hope in the near future to

add the other two attachments. At present there are two automatic pens, worked by electricity, registering the velocity of the wind, also its direction for every minute of

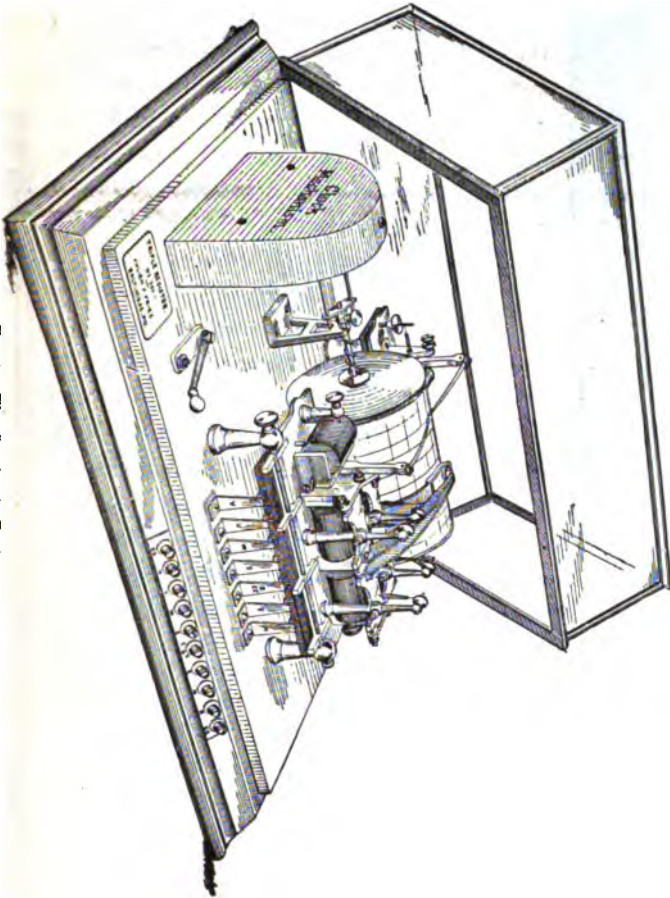


FIG. 5.—The Quadrumple Register.

the twenty-four hours of the day. A blank register is placed upon the brass drum at noon each day. Thus there is recorded, on these records kept on file, a complete

history as to the direction and velocity of the wind, as well as the total number of miles traveled by the wind.

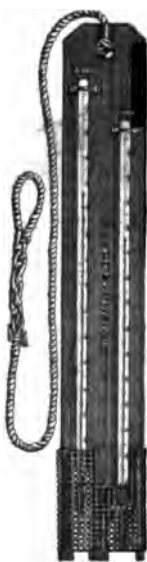


FIG. 6.—Sling Psychrometer.

Fig. 6 is a Sling Psychrometer, an instrument by means of which the relative humidity and dew-point are determined. It consists of a metallic frame upon which are two mercurial thermometers. The bulb of one of these is covered with a piece of linen fitting it closely. To read the instrument the linen-covered bulb is wet with clear water, and by means of the string attached to the framework the instrument is swung in the air. The evaporation from the covered bulb cools it, and its lowest reading is taken, at the same time reading the dry bulb thermometer. The difference between the two bulbs gives the

means of determining the dew-point and saturation of the air of humidity, which are found in printed tables furnished by the United States Weather Bureau.

Fig. 7 is a Soil Thermometer. It is a mercurial thermometer encased in wood, adapted to different depths in the ground, viz., three inches, six inches, twelve inches, twenty-four inches, thirty-six inches and seventy-two inches. The temperatures recorded by these instruments are given in Table III. The lowest temperature of the deepest thermometer, six feet below the surface, was 34.3° F. on March 2, only about two degrees



FIG. 7.—Soil Thermometer.

above the freezing point. a practical fact for plumbers to notice and keep their pipes at least six feet below the surface.



FIG. 8.—Terrestrial Thermometer.

Fig. 8 is a Terrestrial Thermometer. It is a minimum alcohol thermometer, the stem being enclosed for protection. It is kept about six inches from the ground. The radiation, or amount of heat lost by the earth, is shown by the difference of its reading and that of the minimum thermometer. For example, the coldest day of 1895 was on February 12, when the thermometer ten feet from the ground was -29.5° F.; the temperature registered by the terrestrial thermometer was -38.5° F., being nine degrees colder than ten feet above the ground. This difference is called terrestrial radiation.

Fig. 9 is a steel tower situated 300 feet from the main University building; it was erected for the support of the anemometer and the wind-vane. It is 70 feet high, thus lifting those important instruments above the counter currents and atmospheric interferences caused by the University tower. It is connected by wires with the Meteorological Department, where the direction and velocity of the wind are recorded.

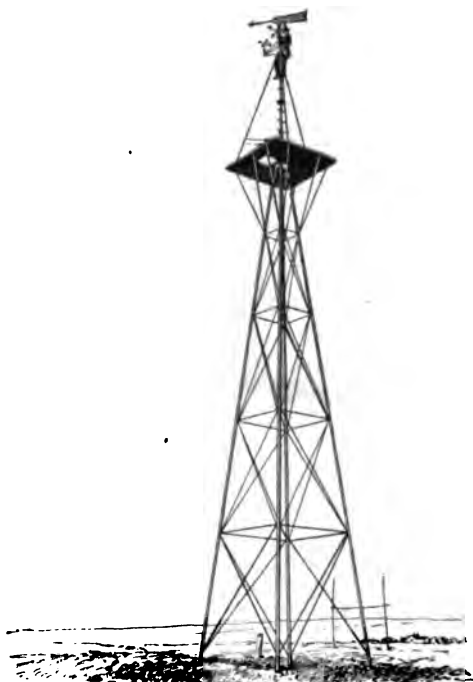


FIG. 9.—Steel Tower.

MAXIMUM AND MINIMUM THERMOMETERS.

These are self-registering. The maximum is a mercurial thermometer with a constriction in its tube near the base. It is mounted horizontally and the mercury which passes the small place in the tube does not go back into the bulb of the thermometer when it cools. The upper end of the column gives the reading of the warmest temperatures since the instrument was last set. The minimum is an alcohol thermometer with a small steel index in the alcohol in its tube. As it cools the surface tension of the alcohol pulls the index down, but as the

temperature rises the alcohol goes up, leaving the top of the index in the position of its lowest point, which gives the reading of the lowest temperature since the instrument was last set.

EVAPORATION AT LARAMIE.

Evaporation from water surface is measured by means of a hook-gauge, measurements being taken every day that the water is not frozen. A tank of galvanized iron holding one cubic meter of water is used. Evaporation can not be accurately obtained during the winter months, there being only a little over six months of the year that water does not freeze so as to interfere with the record. For six months, from April 17 to October 22, it was 37.020 inches. During the time the water was not frozen the evaporation was as follows:

April 17 to 30	2.530 inches
May.....	7.334 inches
June.....	6.236 inches
July.....	7.294 inches
August.....	6.066 inches
September	4.944 inches
October.....	2.616 inches

OBSERVERS.

The observations are kept by the superintendents of the farms. (See the reports of the various farms.) Besides these are the following voluntary observers, viz.: Mrs. C. M. Cheeney of Bates' Park (Freeland), Natrona County; Martin J. Gothberg, Dobin Springs, near Cas-

per, Natrona County; Andrew Falconer, Hat Creek, Converse County; Lafayette Johnson, Little Horse Creek, Laramie County; A. E. Bridger, Sybille, Albany County. The observations at Laramie were made by the Assistant Meteorologist of the Experiment Station, Fred Nelson, who resigned in October, 1895. James P. Cowan was then elected assistant. Thanks are due to all these observers for the interest taken and the time spent in taking the observations and furnishing the records.

EXPLANATION OF THE TABLES.

The mean temperature is given from the maximum or highest and minimum or lowest temperature for each day. The daily range is the difference between these readings. In the relative humidity or per cent of saturation and dew-point tables, the computations are made from the readings of the sling psychrometer, which gives the dry and wet bulb temperatures. They have been computed from the tables in the report of the Chief Signal Observer for 1886, except where the difference between the wet and the dry bulbs is greater than those given, in which instances the tables of Guyot have been used, correcting for altitude in each case. The relative humidity is the per cent of moisture in the air, taking the whole amount the air could hold at the time as 100. The dew-point is the temperature at which this moisture would be precipitated should the air cool to that point. The barometer readings are corrected for temperature from Guyot's tables, each reading being reduced to 32 ° F. The terrestrial radiation, or the amount of heat the earth loses during the night, is given from the differ-

ence in the readings of the terrestrial thermometer, placed six inches above the ground, and the minimum thermometer. It will be noticed that it sometimes occurs that it is warmer near the ground than at the minimum thermometer kept ten feet above the ground. This usually happens on cloudy nights, or when the terrestrial is covered with snow, when little or no heat is lost by the earth. The soil temperatures are taken twice daily, at 7 a. m. and 7 p. m. The soil thermometers are located on the lawn at the University, and give the temperature of the ground. They are about 100 feet from ground that is irrigated, but not near enough to be influenced by the moisture therefrom. The air temperatures given in these tables are from the 7 a. m. and 7 p. m. readings.

A light frost occurred on July 13, 1891, and a damaging frost on August 22. Light frosts occurred on June 5, 6, 7 and 13, in 1892: a killing frost on Aug. 29. Killing frosts occurred on June 6 and August 16, 1893. There were light frosts on May 24 and 25, 1894. In 1895 a killing frost occurred on June 18th; hail on June 6th. July 17th and 31st; several light hailstorms in August.

Table I. TEMPERATURE. 1895.

PLACE.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5
Lander.	19.8	21.0	31.9	46.2	50.0	53.6	65.4	65.2	55.5	48.1	28.1	20.6	42.1
Saratoga.	17.2	17.3	27.1	41.4	.....	.....	.....	.....	.....	.....	.....	.....	†25.7
Sheridan.	14.5	13.8	29.4	47.6	51.2	56.6	63.7	63.4	54.3	45.3	29.1	26.8	41.3
Sundance.	17.7	14.7	27.3	46.0	48.8	55.6	64.6	64.4	55.4	44.3	28.1	21.7	40.7
Wheatland.	.....	.....	.....	.....	54.7	60.6	70.4	72.0	66.7	55.3	38.7	29.6	†57.3
Freeland.	.....	.....	.....	41.2	47.2	53.5	60.3	62.7	54.0	39.5	24.8	18.6	†44.6
Little Horse Creek.	20.4	.....	28.9	46.1	54.9	59.5	65.8	67.7	60.7	41.7	30.1	22.9	†45.3
*Dobin Springs.	.....	.....	30.3	42.8	54.2	63.3	71.9	72.8	64.0	47.9	33.4	26.0	††50.7

*Thermometer broken. †For January, February, March and April. ‡From May to December. §Not including January, February and March
 ‡The average for all except February. ¶Average omitting January and February.

Table II. MONTHLY RANGE OF TEMPERATURE. 1895.

PLACE.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.	19.0	23.6	21.8	25.4	22.4	25.5	26.6	28.1	31.5	20.5	25.0	19.9	24.9
Lander.	27.7	29.3	23.0	19.6	29.4	29.5	21.2	29.3	29.3	28.9	22.6	24.5	26.2
Saratoga.	22.0	25.4	24.7	27.0	.....	.....	.....	.....	.....	.....	.....	.....	†24.8
Sheridan.	25.3	27.8	24.3	31.9	27.9	24.2	33.5	32.1	32.5	35.4	27.3	32.1	29.4
Sundance.	.....	.....	.....	23.5	23.5	24.0	30.1	28.3	27.6	25.4	18.7	16.6	23.1
Wheatland.	19.4	21.7	20.7	21.0	28.5	25.2	27.2	30.1	27.5	35.1	32.6	23.5	†28.7

*For January, February, March and April. †From April, 8 months.

Table III. Weekly Means of Soil Temperatures, Laramie, 1895.

WEEK ENDING	Air Temperature	3 Inches	6 Inches	12 Inches	24 Inches	36 Inches	72 Inches
January 5	18.2	22.6	23.0	24.7	28.7	32.2	39.9
12	21.1	23.0	24.2	25.8	27.7	31.6	38.7
19	23.0	27.2	27.8	28.5	30.0	32.0	38.0
26	15.7	21.2	23.9	26.3	29.5	31.8	37.5
February 2	7.5	15.9	17.6	20.5	26.1	28.6	36.7
9	16.1	24.2	24.9	24.4	28.7	28.0	35.9
16	-7.7	12.4	14.7	18.7	24.7	27.1	34.7
23	29.1	26.3	25.5	23.7	24.7	27.1	34.7
March 2	27.5	32.4	32.7	30.8	29.5	31.6	34.4
9	30.8	29.0	29.5	29.3	30.0	30.7	34.3
16	14.7	29.5	29.9	30.5	31.1	31.6	34.7
23	29.2	32.4	32.9	31.5	31.2	31.9	35.1
30	39.0	42.2	42.0	39.2	35.8	34.7	35.6
April 6	27.1	34.1	35.0	35.9	36.4	36.5	36.7
13	37.7	40.8	40.7	38.2	37.1	36.0	37.2
20	42.1	47.1	47.2	45.1	42.6	40.2	38.0
27	44.5	50.1	50.1	47.6	45.2	42.8	39.6
May 4	42.5	47.8	48.7	48.4	47.5	45.7	41.8
11	48.3	52.4	52.7	50.6	48.2	46.2	42.5
18	47.4	54.3	55.5	53.6	51.2	49.1	43.8
25	47.0	53.1	54.0	53.0	51.4	49.8	45.1
June 1	46.6	50.5	52.1	52.2	51.8	50.6	46.1
8	46.6	50.3	50.4	48.8	48.6	48.0	46.3
15	58.3	58.8	58.3	55.4	52.9	50.8	46.6
22	53.3	60.4	60.8	58.3	54.6	54.3	48.2
29	56.9	64.5	64.5	62.0	59.5	56.6	49.7
July 6	62.4	66.5	66.2	63.3	60.5	57.8	51.3
13	49.1	59.7	60.8	60.8	60.2	57.2	52.4
20	61.7	63.1	63.1	61.1	59.3	57.4	52.8
27	62.7	65.3	65.2	62.7	60.5	58.3	53.2
August 3	60.5	65.4	65.9	64.3	62.5	60.2	54.0
10	60.8	67.1	67.4	65.4	63.2	60.8	54.7
17	62.9	68.0	67.7	65.2	63.1	60.9	55.2
24	60.0	65.8	66.2	64.9	63.4	61.1	55.7
31	58.3	63.0	63.7	62.8	61.9	60.6	55.9
September 7	55.4	63.4	63.5	61.8	60.6	59.4	55.6
14	61.4	64.3	64.2	62.4	60.9	59.4	55.6
21	53.5	62.7	62.9	62.2	60.7	59.5	55.5
28	43.1	54.3	54.1	53.1	55.5	56.1	55.1
October 5	40.7	52.1	52.7	53.6	54.3	54.4	54.0
12	42.6	50.0	49.4	50.2	50.0	51.1	52.8
19	39.3	48.9	49.4	49.6	49.8	50.2	51.5
26	32.5	40.1	42.4	44.0	47.0	48.1	50.5
November 2	34.9	36.2	38.3	39.9	43.0	44.8	49.0
9	24.0	31.9	33.6	37.0	40.2	42.5	47.5
16	27.9	31.1	33.2	34.3	37.3	39.7	45.9
23	26.3	32.6	34.0	35.7	37.8	39.3	44.5
30	30.3	25.8	27.5	30.5	34.5	37.1	43.4
December 7	18.8	24.0	25.1	28.0	32.2	34.9	42.1
14	28.9	30.4	30.0	29.9	35.1	34.1	40.8
21	17.4	22.1	24.5	26.6	30.6	33.2	39.8
28	10.7	18.5	21.1	24.1	27.8	30.6	38.7
Summary	1968.4	2274.8	2310.7	2296.4	2313.6	2315.5	2339.2
Mean	37.9	43.7	44.4	44.2	44.5	44.5	45.0

1895.

LARAMIE.

Table IV.

Month.	Relative Humidity.			Dew-Point.			Barometer.			Wind.			Terrestrial Radiation.		
	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Greatest Velocity	Miles	Direction	Highest	Lowest	Mean
January	95.5	39.8	62.8	25.4	-16.0	6.9	23.210	22.590	22.848	56 miles	10.389	SW	7.7	1.0	3.9
February	100.0	25.7	68.0	27.6	-23.5	5.7	23.254	22.756	22.965	44 "	8.507	SW	9.0	.8	4.4
March	100.0	24.5	59.4	32.7	-6.2	11.3	23.306	22.598	22.922	48 "	12.047	SW	8.0	.4	3.6
April	100.0	15.7	57.2	37.2	0	22.6	23.402	22.576	23.048	57 "	9.111	NW	5.8	0	2.8
May	100.0	15.8	56.5	41.2	15.0	28.9	23.370	22.468	23.014	40 "	10.222	NW	5.6	.2	2.8
June	100.0	20.7	56.1	49.8	13.0	35.3	23.272	22.911	23.137	40 "	8.511	SE	8.0	0	4.1
July	89.2	22.3	56.9	54.5	26.8	42.0	23.339	23.009	23.174	54 "	7.040	SW	9.0	.2	4.0
August	100.0	26.1	56.7	58.0	28.2	42.8	23.368	22.944	23.215	42 "	7.365	SE	8.7	.7	4.0
September	91.0	17.0	50.4	57.7	13.5	31.5	23.367	22.777	23.119	56 "	8.969	SW	8.0	1.9	5.5
October	99.8	20.7	60.2	63.0	6.0	25.7	23.351	22.921	23.187	36 "	6.917	SW	8.5	0	5.6
November	100.0	15.6	61.1	63.0	-24.5	16.3	23.277	22.682	23.004	48 "	8.643	SW	13.0	0	4.9
December	100.0	24.0	59.6	27.2	-15.0	7.9	23.301	22.536	22.980	48 "	11.000	SW	11.0	0	3.2
Summary			701.9			276.9			276.563		108.741				48.8
Mean			58.5			23.0			23.049		9,000.9	SW			4.07

1895.

PRECIPITATION.

Table V.

Place.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Laramie.	0.08	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
Lander.	0.75	1.32	5.48	1.00	2.32	2.03	0.61	1.28	2.26	0.89	1.97	0.00	19.66
Saratoga.	0.70	0.55	3.30	1.00	1.88	3.19	0.57	1.44	1.19	0.57	0.95	0.25	15.04
Sheridan.	1.60	0.90	0.85	2.25	3.47	5.25	1.35	0.45	0.75	2.72	2.10	2.72	23.84
Sundance.	1.20	2.10	2.50	1.48	4.30	3.20	1.46	0.00	0.60	2.00	0.80	0.70	43.06
Wheatland.					0.44	1.80	12.80	0.55	1.50	0.05	1.50	1.45	41.80
Freeland.				1.71	0.44	2.38	2.41	0.45	1.50	0.00	1.00	0.75	18.44
Dubin Springs.	1.60	0.60	3.40	2.50	1.45	2.48	1.87	0.54	1.90	0.00	0.25	0.00	12.22
Little Horse Creek.	0.02	0.05	0.13	3.60	1.38	2.48	1.87	0.54	1.90	0.00	0.25	0.00	12.22

11 inch hail.

{Nine months, omitting January, February and March.

{Eight months, commencing with May.

*From four months.

Summary for 1895.

Highest Temperature.

Laramie, 87° , July 27; Lander, 89° , July 26; Sheridan, 95° , August 15; Sundance, 94° , July 22 and 23; Wheatland, 101° , July 27.

Lowest Temperature.

Laramie, -30° , February 12; Lander, -26° , February 11; Sheridan, -38° , February 7; Sundance, -31° , February 7; Wheatland, (instrument broken); Saratoga, -35° , February 11.

Highest Monthly Range of Temperature.

Laramie, 31.5° , for September; Lander, 31.5° , June; Sheridan, 35.4° , October; Sundance, 25.4° , October; Wheatland, 35.1° , for October (only eight months reported.)

Lowest Monthly Range of Temperature.

Laramie, 19° , for January; Lander, 19.6° , for April; Sheridan, 24.2° , for June, also 24.3° in March; Sundance, 16.6° , in December; Wheatland (for eight months), 23.5° , in December.

The highest annual mean temperature was at Lander, 42.1° .

The lowest annual mean temperature was at Laramie, 38.5° .

The average annual mean temperature for the following four farms, Laramie, Lander, Sheridan and Sundance, was 40.7° .

The greatest annual precipitation was at Sundance, 23.84 inches.

The lowest annual precipitation was at Laramie, 11.15 inches.

The average precipitation for the four farms and Dobin Springs and Little Horse Creek was 16.84 inches.

Other Observations at Laramie.

Highest terrestrial radiation, 15.5° , November 27; lowest terrestrial radiation, 0.0° , April 5, 15, 26, June 3, October 4, November 17, 23, 25, and December 20.

Lowest relative humidity, 15.7, on April 25; mean relative humidity for the year, 58.5.

The highest dew-point was 54.5° , on July 30; the lowest on December 29, -15° ; the mean dew-point for the year was 23° .

The greatest monthly evaporation was in July, 7.294 inches; total evaporation for six months from April 17 to October 22, was 37.020 inches.

The highest barometer was on September 28, 23.388; the lowest on December 15, 22.543; mean barometer for the year, 23.049.

The prevailing direction of the wind was southwest. The greatest number of miles traveled in one month was 12,047, in March; the greatest number of miles in one day, 547, November 26.

Meteorological Notes, 1891-1896.

These notes are made from the records kept for the last five years at the various Experiment Farms.

LARAMIE.

The instruments are kept at the University. The farm is situated nearly three miles southwest, at about the same altitude.

The dome of the University is in latitude $41^{\circ} 18' 37.09''$ North, and in longitude $105^{\circ} 34' 53.75''$ West from Greenwich. It is 30.260 miles west of the 105th meridian. The longitude from Greenwich expressed in time is 7 hours, 2 minutes, 19.58 seconds. Difference in time between Greenwich and Washington is 5 hours, 8 minutes, 12.04 seconds. Difference between Washington and the University, 1 hour, 54 minutes and 7.54 seconds. The length of a degree of longitude in latitude $41^{\circ} 19'$ is 52.030 miles. The altitude of Laramie where Grand Avenue crosses the Union Pacific railroad is 7,149 feet above sea level.

The above accurate data was furnished by Hon. Wm. O. Owen, State Auditor, who was for many years County Surveyor of Albany County.

Two students of the University, L. E. Morris and Harry Houston, run check levels from the point mentioned on the Union Pacific railroad to the room in which the meteorological instruments are kept, and found it to be

38.75 feet above the railroad, making the true altitude of the room 7,187.75 feet.

Temperature.

For the last six months of 1891 the highest temperature at Laramie was 82.5° , on August 13; the warmest day for twenty-four hours was on August 5, mean, 67.4° . In 1892 the highest temperature was 86° , on August 14 and 16; the warmest day for twenty-fours was on July 20; mean, 71.2. In 1893 the highest temperature, 87.2° , occurred on July 21. In 1894 the highest temperature was 87.6° , on July 11; the warmest day for twenty-four hours was 71.5° , on July 11. In 1895 the highest temperature was 87° , on July 27; the warmest day for twenty-four hours was 68.6° , on July 27.

The lowest temperature at Laramie for the last six months of 1891 was -13° , on December 7. The coldest day for twenty-four hours was 3.7° , on December 25. In 1892 the lowest temperature was -29° , on January 11; the coldest day for twenty-four hours was also on January 11, -13.5° . In 1893 the lowest temperature was -9.2° , on February 27. In 1894 the lowest temperature was -27° , on December 28; the coldest day for twenty-four hours was -10.5° , on December 27. In 1895 the lowest temperature was -29.5° , on February 12; the coldest day for twenty-four hours was -21.5° , on February 12.

The mean annual temperature for 1891 was 40.9° ; for 1892, 40.5° ; for 1893, 40.6° ; for 1894, 39.9° ; for 1895, 38.5° . The average for five years was 40.08° .

The greatest daily range of temperature for Laramie in 1891, from July to December, was 50° , on August 7; in 1892 it was 44° , on October 3; in 1893 it was 49° .

on January 24; in 1894 it was 49° , on January 24; in 1895 it was 45.5° , on February 16.

The lowest daily range from July to December in 1891 was 4.2° , on December 28; the mean daily range for the same time was 26.4° . In 1892 the lowest was 1.3° , on December 16; the mean daily range for the year was 23.9° . In 1893 it was 0.5° , on March 20. In 1894 it was 0.5° , on March 20. In 1895 it was 0.5° , on May 30.

By studying the range of temperature of any particular region we can form a good idea of its climatic condition. Observe above that there is sometimes as much as 50° difference between night and day; for example, on August 7, 1891. The average daily range for August, 1892, was 32° , showing that we have warm days and quite cool nights, which condition prevailing throughout the year brings down the average temperature to about 40° F.

The average maximum temperature for August, 1892, was 77.9° .

The average minimum temperature for the same time was 45.7° .

The mean relative humidity from July to December, 1891, was 66.4; for 1892 it was 63.7; for 1893 it was 56.9; for 1894 it was 56.4; for 1896 it was 58.5.

The lowest relative humidity for 1892 was 13.3, on November 14; for 1893 it was 9.2, on January 8; for 1894 it was 10.6, on June 26; for 1895 it was 15.7, on April 25.

The mean dew-point for the last six months of 1891 was 30.1° ; for 1892 it was 24.6° ; for 1893 it was 21.7° ; for 1894 it was 22.5° ; for 1895 it was 23° .

The highest dew-point for 1892 was 55.5° , on June 22; for 1893 it was 54.5° , on July 26; for 1894 it was 56.2° , on July 3; for 1895 it was 54.5° , on July 30.

The lowest dew-point for 1892 was -21° , on January 11; for 1893 it was -16° , on December 16; for 1894 it was -23° , on December 28; for 1895 it was -15° , on December 29.

Evaporation.

The evaporation from July 22 to November 11, 1891, was 22.7 inches; in 1892, from May 24 to October 10, it was 34.91 inches; in 1893, from May to October, it was 37.525 inches; in 1894, from April 26 to October 27, it was 37.166 inches; in 1895, from April 17 to October 22, it was 37.020 inches.

The greatest monthly evaporation for the last six months of 1891 was 8.59 inches for August; in 1892 it was 9.19 inches for July; in 1893 it was 9.35 inches for July; in 1894 it was 7.492 inches for June; in 1895 it was 7.334 inches for May; July was next, nearly the same, 7.294.

Barometric Height.

The mean barometer for the last four months of 1891 was 22.969; for 1892 it was 23.041; for 1893 it was 23.196 (the record was not complete); for 1894 it was 23.054; for 1895 it was 23.049.

The highest barometer for 1892 was 23.382 inches on October 26; for 1893 it was 23.418 on September 1; for 1894 it was 23.389 on July 1; for 1895 it was 23.387 on September 28.

Lowest barometer for 1892, April 3, 22.466 inches; for 1893, January 31, 22.501 inches; in 1894, on January

3, 22.531 inches; in 1895, December 15, 22.543 inches. Average for past four years, 23.075 inches.

Terrestrial Radiation.

Mean terrestrial radiation for the last six months of 1891 was 2.9° ; for the whole year of 1892 it was 3.2° ; for the year 1893 it was 3.5° ; for 1894 it was 4.4° for 1895 it was 4.07° .

The highest terrestrial radiation for 1892 was 9.1° on December 22; for 1893 it was 11° on September 8; for 1894 it was 11° on September 27; in 1895 it was 15.5° on November 27.

Wind.

The greatest number of miles traveled by the wind in one month for each of the last four years was as follows: For 1892, in April, 12,918.3; for 1893, in March, 12,500 miles; for 1894, in March, 12,265 miles; for 1895, in March, 12,047 miles. The average for March for the past four years, 12,432 miles.

The greatest number of miles traveled in one day in 1892 was on January 4, 980.1 miles; in 1893, March 12, 713 miles; in 1894, June 5, 918 miles; in 1895, November 26, 547 miles.

The greatest velocity per hour for the last six months of 1891 was on November 10, 65 miles per hour; for the the year 1892 it was in March, 87.2 miles per hour; for 1893, May 25, 68 miles per hour; for 1894, 56 miles per hour, on April 15, also on June 6; for 1895 it was 54 miles, on September 21.

Precipitation.

The highest monthly precipitation for the year 1891 was 2.92 inches in May; in 1892, 3.97 inches in June;

for 1893 it was 0.54 inches, in June ; for 1894 it was 1.60 inches, in June ; for 1895 it was 2.71 inches in July.

The greatest percipitation for one single storm in 1892 was 3.90 inches melted snow, October 11 and 12. There was also a heavy snow storm June 4 and 5, 1892, giving 3.31 inches melted snow. In 1893, June 4, 0.47 inches. In 1894, April 18, 1 inch melted snow. In 1895, May 31, 0.98 inches.

The annual precipitation for 1891 was 13.92 inches ; for 1892 it was 12.73 inches ; In 1893 it was 3.84 inches ; for 1894 it was 8.63 inches ; in 1895 it was 11.15 inches.

The average annual precipitation for the last five years was 9.85 inches. This low average was due to the very small rain fall of 1893, the amount being 3.84 inches, the smallest on record for this region. During the year 1894 it was also very small, viz., 7.63 inches. The average percipitation from the records, three miles south, at Fort Sanders, for nine years from 1869 to 1878, was 12.92 inches. The average for 1891, 1892 and 1895 is 12.60 inches.

Soil Temperatures.

The following are the mean soil temperatures for the past four years and a half : July 5, 1891, to January 2, 1892, three inches, 44.6 ° ; six inches, 48.5 ° ; twelve inches, 49.8 ° ; twenty-four inches, 50.4 ° ; thirty-six inches, 48.6 ° ; seventy-two inches, 51.7 ° .

In 1892 the air temperature near the ground was 38.4 ° ; three inches in the ground, 42.7 ° ; six inches 44.5 ° ; twelve inches, 44.9 ° ; twenty-four inches, 44.7 ° ; thirty-six inches, 46.1 ° ; seventy-two inches, 45.7 ° .

In 1893, air, 40.8 ° ; three inches, 43.1 ° : six inches,

45.3 ° ; twelve inches, 45.1 ° ; twenty-four inches, 44.8 ° ; thirty-six inches, 45.0 ° ; seventy-two inches, 45.3 ° .

In 1894, air, 39.1 ° ; three inches, 44.5 ° ; six inches, 45.8 ° ; twelve inches, 45.8 ° ; twenty-four inches 45.5 ° ; thirty-six inches, 45.5 ° ; seventy-two inches, 45.7 ° .

In 1895, air, 37.9 ° ; three inches, 43.7 ° ; six inches, 44.4 ° ; twelve inches, 44.2 ° ; twenty-four inches, 44.5 ° ; thirty-six inches, 44.5 ° ; seventy-two inches, 45.0 ° .

The greatest difference between the three-inch thermometer for four years was 1.8 ° ; for the six-inch was 1.4 ° ; the twelve-inch, 1.6 ° ; the twenty-four-inch 1 ° ; the thirty-six-inch, 1.6 ° ; the seventy-two-inch, only 0.7 °

Frosts.

In 1891 there was a light frost July 13. An injuring frost on August 22. In 1892 light frosts June 5, 6, 7 and 13. Killing frost August 29. In 1893, killing frosts June 6 and August 16. In 1894 light frost May 24 and 25. In 1895, on June 18, killing frost.

LANDER.

The Lander farm is situated in latitude about 42° 50' North and 108° 45' West longitude. Altitude, 5,500 feet.

The records have been kept and faithfully reported from the beginning by J. S. Meyer, superintendent of the farm.

This section is protected by surrounding hills and

mountains, and the climate is quite favorable for agriculture under irrigation.

General Summary for the Past Five Years.

The highest temperature for last six months of 1891 was in August and September, 87° . The mean temperature for July was 63.5° ; August, 66.1° , and September, 58.4° . In 1892 the highest was 92° , in August; the warmest day for 24 hours was 79° , August 15. In 1893 it was 94° on July 19; the warmest day for 24 hours was 78.5° , on July 18. In 1894, July 10, it was 94° ; the warmest day for 24 hours was 71° , on July 9 and 10. In 1895, July 26, it was 89° ; the warmest day for 24 hours was 84° , July 26.

The lowest temperature for the last six months of 1891 was -19° in December. In 1892 the coldest was -26° , on January 11; the coldest for 24 hours was -8° on the same day, January 11. In 1893, February 14 was the coldest, -10° below; the coldest for 24 hours was 6° , February 14. In 1894, February 20, it was -24° ; the coldest day for 24 hours was -5° , January 23. In 1895 February 11 was the coldest, -26° ; the coldest day for 24 hours was -10° , February 11.

The mean annual temperature for the last four and one-half years was as follows: The last six months of 1891 the average was 49.3° ; the average for 1892 was 44.8° ; for 1893 it was 44.3° ; for 1894 it was 43.4° ; in 1895 it was 42.1° ; general average, 43.7° .

The greatest daily range of temperature for the last six months of 1891 was 50° , on December 8; for 1892 it was 57° , on December 22; for 1893 it was 45° , on January 26; in 1894 it was 48° , on September 16; in 1895 it was 49° , on September 16.

The mean daily range for 1892 was 27.5° ; for 1893 it was 24.7° ; for 1894 it was 27.8° ; for 1895 it was 26.2° ; the average for four years was 26.55° .

Lowest relative humidity for 1892 was 12.8, on June 8th.

The highest dew-point for 1892 was 62.1° , August 9. Lowest dew-point, -12° , November 7.

Precipitation.

The precipitation for the last six months of 1891 was 4.23 inches. Total for 1892 was 11.94 inches. The greatest monthly precipitation was in April, 4.89 inches. The greatest precipitation during one single storm for 1892 was 1.91 inches, July 7. The total precipitation for 1893 was 11.62 inches; for 1894 it was 10.72 inches; for 1895 it was 19.66 inches. The average for the past four years was 13.49 inches.

Frosts.

There were rather heavy frosts on June 4 and 13, 1892, a light frost on August 28 and killing frosts on October 12 and 14. In 1893 there were killing frosts on May 24, 25, 26 and 27, and September 22 and 23. In 1895, killing frosts June 17 and 18, and September 7, 21, 22, 23, 24 and 29.

SARATOGA.

Saratoga is situated in latitude about $41^{\circ} 28'$ and longitude $107^{\circ} 5'$. Altitude about 6,800 feet. Being located in a broad valley, and so near the same latitude and altitude as Laramie, the climatic conditions are quite similar.

The records were kept by the Superintendent of the farm, J. D. Parker, from the beginning of the work in 1891 until June, 1895, the experiments having then stopped on the farm on account of the lack of water.

General Summary for Four Years.

The highest temperature for the last six months of 1891 was 93° , on August 12. July and August had the highest mean, each 66.6° . In 1892 the highest was 92° on August 2 and 3; the warmest day for twenty-four hours was on July 24, viz., 72.5° . In 1893 the highest temperature was on July 21, 89° ; the warmest day for twenty-four hours was 70.5° , on July 9. In 1894 the highest temperature was 88° , on July 10; the warmest day for twenty-four hours was 72.5° , on July 10.

The lowest temperature for the last six months of 1891 was -15° , on December 25. For 1892 it was -26° , on December 16 and 17; the coldest day for twenty-four hours was -6° , on December 17. The lowest temperature for 1893 was -13° , on February 13; the coldest for twenty-four hours was 5° , on February 13. The lowest temperature for 1894 was -29° , on December 27; the coldest for twenty-four hours was -10° , on December 27.

. The following is the average temperature for each of the last four years: The last six months of 1891 the average was 45.4° ; the average for 1892 was 41.6° ; for 1893, it was 39.3° ; for 1894 it was 40.3° . The general average for 1892, 1893 and 1894 was 40.4° .

The greatest daily range for the last six months of 1891 was 56° , on October 18; for 1892 it was 53° , on

June 1; for 1893 it was 46° , on June 19; for 1894 it was 66° , on November 15.

The lowest daily range for 1891 (six months) was 5° on December 2; for 1892 it was 2° , on January 13; for 1893 it was 5° , on April 25; for 1894 it was 3° , on December 24.

The mean daily range for 1892 was 29° ; for 1893 it was 27.1° ; in 1894 it was 29° . The mean daily range for 1892, 1893 and 1894 was 28.4° .

Precipitation.

The precipitation for the last six months of 1891 was 4.65 inches; the total for 1892 was 8.91 inches; for 1893 it was 14.52 inches; for 1894 it was 12.73 inches. The average for 1892, 1893 and 1894 was 12.05 inches.

The greatest precipitation for one single storm in 1892 was 1.61 inches on October 11 and 12; in 1893, 1.01 inches on June 2; in 1894, 1.11 inches on March 19. In 1895, March 29 and 30, the heaviest snow-storm for years, 24 inches. Observations stopped in June, 1895.

SHERIDAN.

Sheridan is situated in about $44^{\circ} 48'$ latitude, and $106^{\circ} 57'$ longitude. Altitude, 3,750 feet. It is the most northern part of the State from which we have reports of the weather.

The observations were reported by James A. Becker up to 1893; since then by John F. Lewis, Superintendent of the Experiment Farm.

The comparatively low altitude compensates in a great measure for the latitude. It is subject to greater extremes of heat and cold than any of the other farms. It is but a few miles from the Montana line. The growing season is comparatively long, and the agricultural possibilities very good.

A General Summary for the Last Four Years and a Half.

The warmest temperature observed for the last six months of 1891 was 90° , in August. The mean temperature for August was 65.3° . In 1892 the highest temperature was 89° , on August 24 and 31; the warmest day for twenty-four hours was 80.5° , on August 14. In 1893 the highest temperature was 102° , on July 20; the warmest day for twenty-four hours was 81.5° , on July 23. In 1894 the highest temperature was 96° , on August 27; the warmest day for twenty-four hours was 75° , on July 30. In 1895 the highest temperature was 94° , on July 2, 24 and 27; the warmest day for twenty-four hours was 72.5° , on August 2 and 13.

The lowest temperature for the last six months of 1891 was -24° , on November 16. For 1892 it was -46° , on January 11; the coldest for twenty-four hours was -22.5° , on January 11. For 1893 the lowest temperature was -45° , on February 1; the coldest for twenty-four hours was -27.5° , on January 31. For 1894 the lowest temperature was -36° , on January 24; the coldest for twenty-four hours was -19.5° , on January 23. For 1895 the lowest temperature was -38° , on February 7; the coldest for twenty-four hours was -17.5° , on February 7.

The following is a list of the mean temperatures for

the last four years, some of the records for the last six months of 1891 having been lost: The average for 1892 was 41.3° ; for 1893 it was 41.7° ; for 1894 it was 42.8° ; for 1895 it was 41.3° . The mean of the annual temperatures for the last four years was 41.5° .

The record showing the greatest daily range for the last six months of 1891 is not complete. For 1892 it was 55° , on October 4; for 1893 it was 55° , on October 21; for 1894 it was 62° , on October 16; for 1895 it was 67° on January 4.

The lowest daily range for 1892 was 1° , on November 24; for 1893, 0° , on April 29 and November 17; for 1894 it was 3° , on March 3 and 20 and November 18; for 1895 it was 2° , on June 2.

The mean daily range for 1892 was 28° ; for 1893 it was 28.5° ; for 1894 it was 30° ; for 1895 it was 29.4° . The average for the four years was 28.97° .

Precipitation.

The precipitation for the last six months of 1891 was 5.04 inches; for 1892 it was 16.26 inches; for 1893 it was 12.60 inches; for 1894 it was 12.49 inches; for 1895 it was 15.64 inches.

The greatest monthly precipitation for 1892 was 3.29 inches in June; for 1893 it was 3.40 inches in May; for 1894 it was 3.15 inches in March; for 1895 it was 2.25 inches in April.

The greatest precipitation during one single storm in 1892 was 1.56 inches, October 11; in 1893 it was 1.76 inches, May 20; in 1894 it was 0.53 inches on April 7; in 1895 it was 0.95 inches on June 1.

Frosts.

Light frosts occurred in 1892 on May 13, 20 and 21; killing frosts May 2 to 6, and September 11.

In 1893, killing frosts May 27 and September 23.

In 1894, hail and snow on April 18.

In 1895, September 19 and 20, heavy snow; ice two inches thick; August 30, hail did some damage; several light frosts in June; killing frosts May 11, 16 and 29.

SUNDANCE.

Sundance is situated in latitude about $44^{\circ}24'$ and longitude $104^{\circ}22'$. Altitude about 4,750 feet.

The observations were reported at first, up to 1894, by Thomas A. Dunn, superintendent of the farm, but since then by the present superintendent, A. E. Hoyt.

The comparatively low altitude and the protection from mountains, together with the highest annual precipitation in the State, render the climate mild and the season of growth long.

It is the only farm of the Experiment Station where crops, generally, are matured without irrigation.

Notice further on the comparatively high precipitation for the past four years.

General Summary for the Past Four Years.

The highest temperature for the last six months of 1891 was 96° , on August 6; the mean for August was 63.5. In 1892 the highest temperature was 98° , on August 15; the warmest day for twenty-four hours was

77.8 °, on August 12. In 1893 the highest temperature was 96 °, on July 22 and August 6; the warmest day for twenty-four hours was 79 °, on July 11 and 22. In 1894 the highest temperature was 94 °, on July 30; the warmest day for twenty-four hours was 79.5 °, on August 21. In 1895 the highest temperature was 94 °, on July 12; the warmest day for twenty-four hours was 77 °, on August 4.

The lowest temperature for the last six months of 1891 was —10.5 °, on November 16. In 1892 the lowest temperature was —26 °, on January 18; the coldest day for twenty-four hours was —15 °, on January 10. In 1893 the lowest temperature was —31.5 °, on January 31; the coldest day for twenty-four hours was —14 °, on February 7. In 1894 the lowest temperature was —28 °, on January 23; the coldest day for twenty-four hours was —23.5 °, on January 23. In 1895 the lowest temperature was —31 °, on February 7; the coldest day for twenty-four hours was —10.5, on February 7.

The average temperature for 1892 was 41.2 °; for 1893 it was 40.6 °; for 1894 it was 42.3 °; for 1895 it was 40.7 °. The general average for the four years was 41.2 °.

The greatest daily range for the last six months of 1891 cannot be determined, as the instrument was broken. For 1892 it was 46 °, on September 26; for 1893 it was 49 °, on February 4; for 1894 it was 49 °, on March 28; for 1895 it was 45 °, on April 16 and July 24.

The lowest daily range for the last six months of 1891 (instrument broken); for 1892 it was 2 °, on May 2; for 1893 it was 2 °, on February 5, April 24 and May 24;

for 1894 it was 2° , on December 7; for 1895 it was 3° , on November 5.

The mean daily range for 1892 was 22.8° ; for 1893 it was 24.9° ; for 1894 it was 23.9° ; for 1895 it was 23.1° .

Precipitation.

The precipitation for the last six months of 1891 was 11.70 inches; in 1892 it was 24.69 inches; in 1893 it was 16.56 inches; in 1894 it was 19.99 inches; in 1895 it was 23.84 inches. The general average for the past four years was 21.27 inches.

The greatest precipitation for one single storm for 1892 was 1.3 inches on January 31; for 1893 it was 4 inches melted snow on January 14; for 1894 it was 1.62 inches on May 16; for 1895 it was 2.01 inches on June 4

Frosts.

In 1892 light frost on June 5; killing frost September 11. In 1893, killing frosts May 22 and September 23. In 1894, light frosts every night in October. April 16, 1894, first hail of season.

WHEATLAND.

Wheatland is situated in about 42° latitude, and longitude $104^{\circ} 54'$ West. Its altitude is 4,700 feet, and being on the undulating plateau which extends from the Laramie range of mountains along the North Platte river into Nebraska, it is subject at times to the hot, dry winds of the plains, but they are not destructive. The season of

growth is long, warm and favorable to crops, while the winters are not severe.

Most of the above description is taken from the Meteorological Bulletin of 1892. It is quite necessary to append the following note given in that Bulletin:

"The thermometers at Wheatland are not kept in a regular instrument house of the weather service, as at the other stations, but are located in a sheltered position, which would probably give little difference in temperature. However, this fact should be borne in mind in considering the above highest temperature, as it may be excessive."

The observations are reported by M. R. Johnston, superintendent of the Experiment Farm.

General Summary for the Last Four Years.

The highest temperature for the last six months of 1891 was 96° , on August 4; the warmest day for twenty-four hours was 78° , on August 6; the mean for August was 65.7° . In 1892 the highest temperature was 109° , on July 21; the warmest day for twenty-four hours was 88.5° , on July 21. For 1893 the highest temperature was 108° , on June 18; the warmest day for twenty-four hours was 84.5° , on July 12; it was 84° on June 18. For 1894 the highest temperature was 99° , on July 11; the warmest day for twenty-four hours was 81.5° , on July 10. For 1895 (the last eight months) the highest temperature was 101° , on July 27; the warmest day for twenty-four hours was 81.5° on August 11.

The lowest temperature for the last six months of 1891 was 0° , on November 17 and December 25; in

1892 it was -21° , on January 11; in 1893 it was -16° on January 28; in 1894 it was -22° , on January 26.

The coldest day for twenty-four hours in each year was as follows: In 1892, -12° , January 18; 1893, 6° , on November 30; 1894, 0° , on February 19; 1895 (for last eight months), 13.5° , on December 29.

The mean annual temperatures for the last four years were as follows: For the last six months of 1891 it was 48.35° ; for 1892 it was 49.2° ; for 1893 it was 48.8° ; for 1894, (instruments broken late in 1894, which interfered with a complete record for 1894 and 1895.)

The greatest monthly range for the last six months of 1891 was 49° , on November 4; for 1892 it was 57° , on March 17; for 1893 it was 55° , on March 30; for 1894 it was 52° , on September 24; for 1895 (last eight months) it was 52° , on November 22.

The lowest daily range for the last six months of 1891 was 5° , on September 8 and December 30; for 1892 it was 1° , on January 16; for 1893 it was 0° , on April 17; for 1894 it was 1° , on April 30; for 1895 it was 7° , on December 10.

The mean daily range for 1892 was 29.4° ; for 1893 it was 30.9 ; for 1894 (November and December missing) it was 29.9° ; for 1895, record not complete.

Precipitation.

The precipitation for the last six months of 1891 was 5.54 inches; total for 1892 was 14.51 inches; for 1893 it was 6.42 inches; for 1894 it was 10.13 inches; for 1895 (for eight months, commencing with May) it was 13.06 inches.

The average for the three years, 1892, 1893 and 1894, was 10.35 inches.

The greatest precipitation during one single storm for 1892 was 1.30 inches on May 13; for 1893 it was 0.6 inches on October 11, and six inches snow on December 24, which is equivalent; for 1894 it was 1.25 inches on June 15 and July 3. For 1895 (eight months, commencing with May) it was 1.5 inches on June 2.

Frosts.

Light frosts in 1892 on June 6 and October 5; killing frost October 22. In 1893, light frost May 19 and killing frosts on September 23, 24 and 25. In 1894, light frost May 3.

Notes.

The remarkable growth of cereals and all root-crops, by irrigation, at all the experiment farms, and at Sundance without irrigation, illustrates the adaptation of the climate to the growth of most of the farm products grown in northern states.

The farms can be grouped into pairs, and it is interesting to observe the parallelism between them. Laramie and Saratoga can be grouped together as the most southern points in an east and west line, they being about the same latitude and altitude ; consequently they are very similar in temperature and nearly the same in amount of precipitation, and in agricultural productions. Lander and Wheatland can be grouped on the same principle, as representing a line east and west across the middle of the state, Lander being very near the center, and Wheatland about 200 miles to the east. Their altitude as well as their agricultural possibilities are very nearly the same. Sheridan and Sundance are in an east and west line in the extreme northern part of the state, and in altitude are lower than either of the others. They have greater extremes of heat and cold than the other points, although their annual temperature is a little higher than that of Laramie and Saratoga, which are 250 miles further south ; but the temperature at Laramie and Saratoga is more uniform, on account of their more favorable latitude and higher altitude. They do not have the extremes of summer and winter as at the other farms.

To illustrate, let us take the extreme northern and southern farms, viz., the ones at Sheridan and at Laramie. The highest temperatures at Sheridan for the last four years were 89° , 102° , 96° and 94° . At Laramie for the same time, 86° , 87.2° , 87.6° and 87° . The coldest days at Sheridan for the same years were -46° , -45° , -36° and -38° ; at Laramie for the same time, -29° , -9.2° , -27° and -29.5° . The annual temperature at Sheridan for the four years was as follows, viz, 41.3° , 40.6° , 42.8° and 40.7° ; and at Laramie it was 40.5° , 40.6° , 39.9° and 38.5° . The average daily range at Sheridan for four years has been 29° ; at Laramie 24.8° .

July has averaged the warmest at all the farms, and August has ranked second. The averages for June and September have been nearly the same. February has averaged the coldest at all the points; January ranked second and December third; but in 1892 January was the coldest December ranked second and February third. In 1893 February was the coldest December ranked second and January third. In 1894 February was the coldest January ranked second and December third. In 1895 February was the coldest January ranked second and December third.

The mean for each month at Laramie for the last four years was as follows, viz: January, 22° ; February, 20° ; March, 29° ; April, 37.2° ; May, 46.6° ; June, 55.2° ; July, 62.2° ; August, 61.6° ; September, 53.8° ; October, 44.2° ; November, 28° ; December, 21° . When February has not been the coldest month the annual temperature has been comparatively warm.

The sunshine record has not been worked out for all

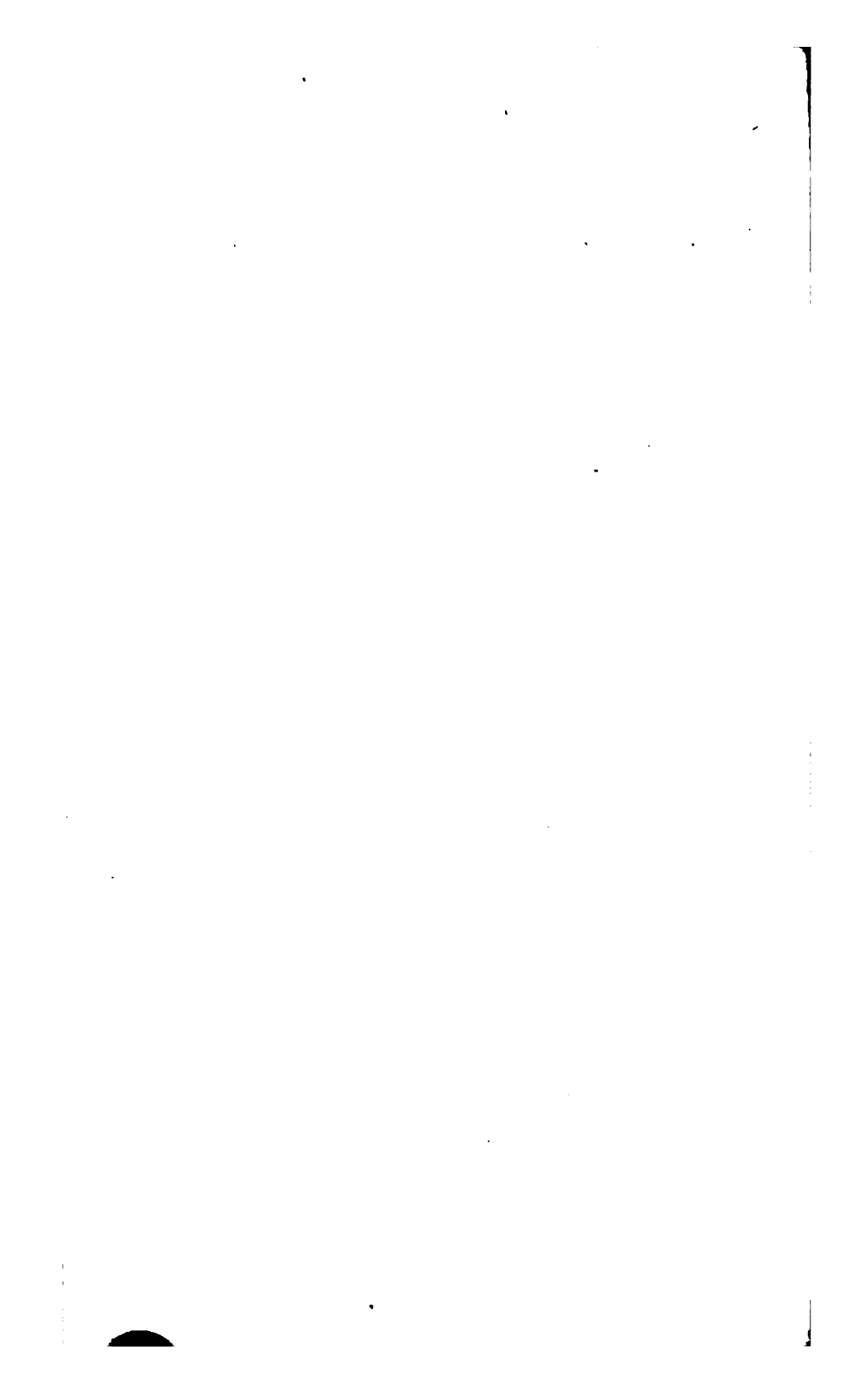
the farms ; but we will quote enough from Bulletin Number 10, 1892, to give a fair idea of the percentage of sunshine prevailing in Wyoming, taking the center of the state, the southern and the extreme northern points.

The sunshine at Lander indicates 13.6 per cent cloudy days ; nearly 25 per cent clear ; the remaining 61.4 per cent were partially cloudy, termed fair. September was the sunniest month, having no cloudy days, while May was the cloudiest, having 11 cloudy days.

Saratoga observations indicate 16.5 per cent cloudy days, with April the cloudiest month ; 38.3 per cent clear days, with September the sunniest month ; the remaining 45.2 per cent are fair.

Sheridan observations on the character of the day indicate 21 per cent cloudy days, with May the cloudiest month ; 51.4 per. cent clear days, with September the sunniest month ; the remaining 27.6 per cent being fair.

This is sufficient to show the very high percentage of sunshine in the State of Wyoming.



UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 28.

MAY, 1896.

First Report on the Flora of Wyoming

BY THE BOTANIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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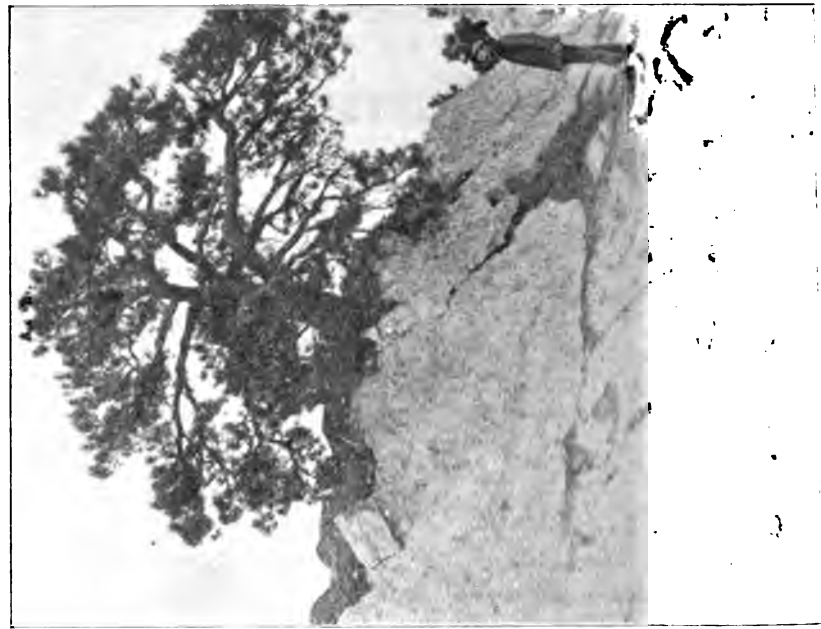
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ERRATA.

- Page 83 read *Erysimum* for *Erisyum*.
 Page 99 read *Glycyrrhiza* for *Glyceria*.
 Page 170 read *Monolepis* for *Monolepsis*.
 Page 199 read *Cryptogramme* for *Chryptogramma*.
 Page 142 line 5 from bottom read Triassic for Tertiary.



ROCKY MOUNTAIN YELLOW PINE. Grand Hills, 12 miles north of Lusk, 1 eighth from tree to point where root enters the ground, 40 feet. Showing remarkable root development.

FIRST REPORT

—ON THE—

FLORA OF WYOMING.

BY AVEN NELSON.

INTRODUCTION.

Among the duties planned by and for the Botanist of the Experiment Station for the year 1894 were the following :

1. To study the Fungi affecting the ordinary farm crops and the best means of combatting the same.
2. To give attention to the weed question, with a view to finding effective methods for exterminating or preventing the spread of the more troublesome ones.
3. The building up of the herbarium.
4. The preparation of a report upon the flora of the state.

These all received attention to the extent of the time that could be spared from other imperative duties, such as those of the classroom and the routine work of the Station, but it was found necessary to continue the same subjects for 1895. During that time one phase of the first has had attention in Bulletin No. 21, "The Smut of Grains and Potato Scab;" the second in Bulletin No. 19, "Squirrel-Tail Grass (Fox-Tail)," our worst weed, and a Press Bulletin on the "Russian Thistle." The third has, of course, gone on incidentally with and preparatory to the fourth.

Although what has been done in the study of the flora of the state has cost no little time and labor yet the work seems but barely begun. The preparation of a full and reasonably inclusive report on the flora of a great state of nearly 100,000 square miles would be the work of years for a corps of men devoting their full time to the matter in hand, so one man with a full slate of college teaching and other Experiment Station duties, besides that of working up the flora, would lose courage were it not for the absorbing interest of the subject itself. Since to delay the report until it should be approximately complete would project it far into the future and might possibly result in its never being published, it has seemed advisable to publish the results thus far attained. As the work goes on and results accumulate, other reports may, from time to time, appear to record the additions.

COLLECTING TRIPS.

The basis for the following brief report and the catalogue of species rests mainly upon the collections made by the writer in 1894 and in 1895.

With one exception, as given below, no systematic work in collecting had previously been done. In 1892, Prof. B. C. Buffum, at that time acting botanist of the Station, spent the mid-summer months in the field collecting—primarily to secure for the University and the Station a collection of the native grasses and forage plants, an exhibit of which was to be made at the World's Fair at Chicago in 1893. Incidentally much more was done, for a considerable amount of good material, other than grasses, must be put down to the credit of the expedition.

From this material were obtained the numbers which formed the nucleus of the present collection in our her-

barium. Quite a large part of the state was covered during this trip, extending from Laramie, on the south, to Lander and the Wind River Mountains on the north-west, to Sheridan and the Big Horn Mountains on the north, and Sundance, Fort Laramie, and Wheatland on the east. How many numbers were collected, I am unable to state, as no field or collection numbers were made use of, but in the succeeding catalogue of plants those species where no collection number is noted, are generally to be credited to this expedition. In the Gramineæ and Cyperaceæ much the larger number of species are the result of this earlier expedition in which these groups received such thorough-going attention that in the later collecting trips it seemed advisable to concentrate attention upon the other Phanerogams.

It may be of interest to give briefly the history of the field work that furnished the material upon which this report rests.

1894.

During the continuance of the spring term of school, operations had to be confined to Laramie and adjacent territory. Mornings and evenings, holidays and Saturdays were used with all diligence. The most distant point reached was Table Mountain, about twenty miles to the east, and on the west the Laramie River served as boundary line. Limited as was the area covered and late as seasons are at this altitude, June 30 saw 300 numbers collected and stored in duplicate.

At the annual meeting of the Board of Trustees at the close of the school year, provision was made for an expedition to go into the field during the summer vacation, in the interest of the departments of geology and

botany. Preparations for setting out were perfected as rapidly as possible, but it was not until July 7 that the start was made.

Beside the writer

THE PARTY

consisted of W. C. Knight, Professor of Geology in the University and Geologist of the Station; Mr. W. H. Reed, who furnished a large part of the outfit for the expedition; Mr. Geo. M. Cordiner, a student at the University, who accompanied the party as the writer's assistant.*

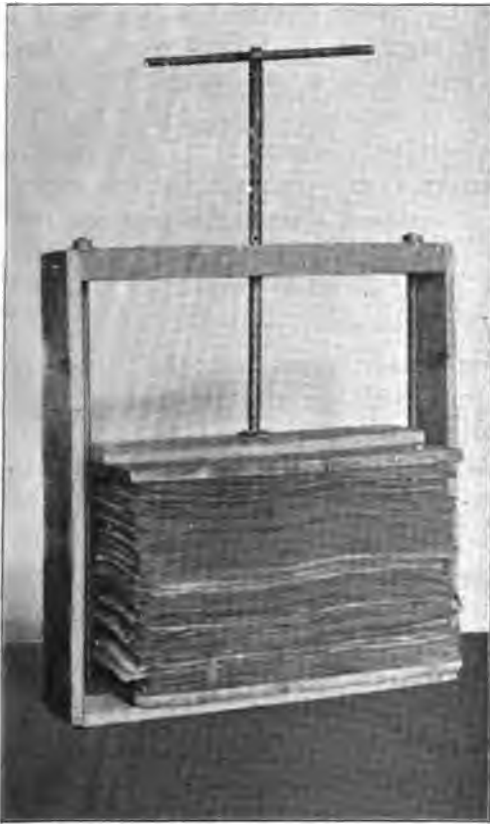
The expenses of the expedition were reduced to a minimum as they consisted of only the actual living expenses of the party in the field, plus the expense incident to securing the services of Mr. Reed, with his two teams and wagons and one saddle horse. The camp equipage consisted of all the necessary utensils, ample bedding, a tent, (which, owing to the perfect weather, was rarely used), a stock of groceries, besides the necessary apparatus for collecting in both botany and geology.

The botanist's outfit may be of interest and was as follows: Two ordinary-sized tin collecting cans, one of which had a number of small compartments at the end for diminutive and delicate objects, and one large tin vasculum—so large that it was always referred to as the "tin trunk." This was indispensable during the long mountain trips, when it was a desideratum to be able to bring back once for all a large amount of material. The most efficient instrument for uprooting plants, both on the plains and among the rocks in the mountains, was found

*It is with deep sorrow that I record the death of this noble young man. On March 14, 1895 he received fatal injuries during a fire in Laramie by being caught under the falling walls of a building from which he was helping to remove goods. While in the field he greatly endeared himself to the writer by his constant cheerfulness, his remarkable faithfulness to duty, his high efficiency and his moral worth.

to be a carpenter's strong chisel about three-fourths of an inch broad. Of course, a stout knife is not to be omitted from any collecting outfit.

Five plant presses were carried and found none too many at times, but at other times two would have been more than enough.



Four of these were slat presses, the pressure in two being applied by straps and in the other two by cords as in the Acme press. The fifth, and most important one, was a screw - press and as it filled its purpose so admirably and proved so valuable an adjunct to the outfit, I add here a figure and brief description.

The base and the top bars are of oak, $2 \times 4\frac{1}{2} \times 20$ inches, the distance between them being 21 inches. They are united by one-half inch bolts so placed as to be eighteen inches apart. To

keep the base and top in place when the pressure is relaxed strips of board $\frac{1}{2} \times 4\frac{1}{2}$ inches are nailed to the ends. The floor to receive the package of plants is 12×18 inches, made by nailing pine board $\frac{3}{4}$ inches thick crosswise of the base. The screw is a $\frac{3}{4}$ -inch bolt with 15 threads to the inch, about 15 inches thread bearing. A square nut is sunk on the under side of the top bar and held in position by a piece of tin tacked over it, the tin having a circular hole in it large enough to admit the bolt. The follower is made of a strip of pine $1 \times 5 \times 18$ inches, crosswise on which is nailed pine board $\frac{3}{4}$ of an inch thick, making the surface 12×18 inches. On the upper face of the follower is fastened a small flat piece of iron with a sunk center to receive the end of the screw. The projecting end of the screw is made square, on which a removable handle with a square slot is used.

This homely, home-made press has the following advantages: It will furnish all the pressure that can possibly be desired; a large quantity of material can be handled at one time; coarse harsh plants can be forced into shape and held there; packages that have been in the screw press for twenty-four hours can be satisfactorily handled in the strap presses; moisture can be forced out so rapidly that by frequent change of driers the drying of the material may be considerably hastened; natural colors can be preserved in plants that by ordinary means would blacken; it furnishes a safe and convenient way for carrying the material while in press and in every way greatly facilitates the making of good flat specimens.

It was found that the capacity of this press is much greater than its dimensions would indicate. With a good quality of carpet felt for driers and single pressing sheets,

cut to size (newspaper quality, 'unprinted'), it was possible to do good and rapid work. Experience shows that more plants are spoiled by too little than by too much pressure.

ROUTE AND PRINCIPAL CAMPS.

The accompanying map will indicate the route in a general way but of course cannot show the miles and miles of ground covered in the vicinity of the various camps, nor the wide detours made on horseback during the days the party was traveling. At a rough guess, more than two-thirds of the time was spent on the road, as the distance covered was upwards of 1,000 miles.

The days of travel were busy ones for the Botanist and his assistant, for at noon the collections of the morning were put into press, the driers on all the other recent material were changed, the damp driers thrown out on the hot sand and again collected. When camp was made for the night the afternoon collections were cared for, and, if they chanced to be heavy, the task was often completed by the campfire.

To enter into a detailed account of the journey would take up too much space, possibly to no purpose, so the following skeleton account must suffice: The route from Laramie took a north-east direction over the Laramie Hills past Grant, Wheatland and Uva postoffices to the Platte River, where camp was made July 10. After four days the camp was moved in turn to Hartville, a mining district, to Whalen Canon, and to the Mexican Mines. From this place a side trip was made by the Botanist and his assistant to Lusk. Camp was broken at the Mexican Mines on July 22, and the Platte River again reached at Orin Junction. From this place the river was followed

to Bessemer, passing in turn Douglas, Glenrock and Casper. From Bessemer, Poison Spider Creek was followed to its head near Garfield Peak in the Rattlesnake Mountains. Camp for a day was made on Wallace Creek at the foot of the peak. Up to that date, July 29, this was the richest collecting ground so far encountered. The road from there to the Big Popo Agie river lay across a barren desert, whose few streams were dry and the occasional springs mere mud holes, strongly impregnated with alkali.

The evening of July 30, caught us at Alkali Springs, a bog so densely impregnated with salt that only the almost famished horses could swallow a mouthful, and to one or two of the animals the draught came near proving fatal. There was no grass except an occasional stalk of salt-marsh grass—*Distichlis maritima* and *Triglochin maritima*. Thirsty as every member of the party was, after an all day's drive on the burning plain, not even coffee made from such water could be swallowed. Just at sunset a diminutive shower fell, and a dusty wagon sheet was called into service to catch the precious drops. As the little pool formed in the sagging center of the canvas what delicious draughts of nectar, thickened with the dust of many days, were dipped up with the old tin cups.

At four o'clock next morning, breakfastless, the party started for Beaver Creek, twelve miles distant. Breakfasting here where water was good and abundant, even the weakened horses were somewhat revived, though feed was still very scarce. Early in the afternoon the Big Popo Agie was reached by hard effort, and here three days were spent in camp to allow the sick and famished horses to recuperate. Water and grass

were both abundant, and the horses soon showed the effect of better treatment.

August 3, the camp was moved to Lander, where a stop of twenty-four hours was made, after which the expedition proceeded to and up the Big Wind River. The route lay across the Shoshone Indian Reservation, one camp being made at Fort Washakie. It was found necessary to ford the Big Wind River thirteen times before Dubois postoffice was reached. This is the last outpost of civilization on the river and it is near this place that the trail over the Wind River Mountains through Union Pass leads off from the river.

The ascent through the pass was begun on August 10, the summit of the range being reached early on the 11th. A most varied and beautiful vegetation was present on every hand all the way up, and at the highest point in the pass, about 9,500 feet, the open parks among the Spruce groves were covered with the wildest profusion of flowers—a veritable botanist's paradise. Two full days were spent here, but that was far too short a time even though the days were considerably lengthened out by the cheerful evening and early morning campfires. Union Peak, with its snow banks, the moist, dense copses on its slopes and the small fertile valleys at its base rivalled each other in the richness of their treasures.

The days were slipping by and the stay could not be prolonged even here, so on the 14th we turned our faces toward the three Teton peaks, whose lofty summits, though yet a hundred miles away, were seen from our present point of vantage standing out against the pellucid sky like mighty spires, their seamed and snow-flecked faces shining with a radiance possible only in such an

atmosphere as this. Over trails all but impassable, up hill and down dale, most laboriously we advanced and at last, on the 18th, camp was made in a Cottonwood grove on the banks of the Snake River in Jackson's Hole, near the foot of the Grand Teton.

Here some days were spent, during which an ascent of the Grand Teton was made. On the 20th three of us began the ascent. That night was spent on the ~~shore~~ of a small lake at about 9,500 feet. The next morning the more precipitous slopes were scaled, but at about 11,000 feet further progress was stopped by a frightful chasm which entirely cut off all communication with the spire-like summit that still towered above us. The descent was made more rapidly, and at nightfall on the 21st we were again in camp, loaded down with the collections of that and the preceding day.

This camp marked the most distant point reached by the expedition and on the afternoon of the 22nd the return journey was begun. The route lay up the Gros Ventre River, up Bacon Creek and over the divide separating it from Green River. On reaching Green River we camped for twenty-four hours, after which we proceeded to Cora postoffice on New Fork. At this point the route took a general south-east course, skirting the foot hills on the west of the Wind River range. The following streams were crossed in succession, viz: New Fork, Boulder Creek, East Fork, Silver, Willow, and Muddy Creeks, the Big and the Little Sandy. This brought us to South Pass City, the oldest mining camp in the Wind River Mountains, thirty miles south of Lander.

At this point, on September 1, the writer found it necessary to sever his connection with the expedition and

return to Laramie. Mr. Cordiner remained with the party, and, although it was becoming late in the collecting season and the route lay through a rather barren region, made doubly so by the large flocks of sheep that had been driven over the range, yet a number of interesting species were secured, but unfortunately, most of this material was lost by the burning of a car in the Laramie yards the night of its arrival.

The writer was in the field eight weeks and two days and the other members of the party ten weeks and three days. During this extended trip 900 numbers were made (including some that were secured after the return to Laramie), which, added to the 300 collected during the spring, made 1,200 numbers for the season of 1894. These were all collected in duplicate, ten or more sheets of each number being prepared whenever the material could be procured. This omniverous collecting resulted in quite a percentage of duplicates, so that the actual number of species, not counting forms, was probably not much above 1,000.

1895.

In 1895 it was not found possible to spend even the whole of the vacation in the field but all available time was utilized during the entire season. Especial effort was directed toward procuring such species as were not secured in 1894, and it seemed wise to concentrate effort upon a much more limited area. To this end four expeditions were planned and carried out.

The first one left Laramie June 27, going to the east and working Pole Creek, Table Mountain and adjacent territory, 103 species being secured. The second left Laramie July 25, camp being established at Cummins

City, from which point the surrounding mountains and valleys were scoured and resulted in 123 numbers. The third expedition left for Laramie Peak, seventy-five miles distant, on August 3 and returned with 117 numbers. The fourth made two camps, one in the Centennial Valley and one at the La Plata Mines near the summit of the Medicine Bow (Snowy) range. From these two points adjacent territory was worked and yielded 192 species, many of them quite rare.

Besides the above species, there were collected at various times during the season 135 numbers, making a total for 1895 of 670 numbers. As these were all in duplicate, approximately in tens, the total number was near 6,700.

Of the 670 species about one-half are new as compared with the collections of 1894.

PLANT ZONES.

Recent writers have made much of plant zones as limited by given lines of elevation. There is, no doubt, considerable truth in the theory that fairly well marked belts are found, but I think it is possible to overestimate the importance as well as the distinctiveness of such zones. There are so many other factors that enter into the problem, such as moisture, soil and exposure that its solution becomes peculiarly difficult. The zones sink and rise in conformity as much with the configuration of the land, the absence or presence of arboreal vegetation, the character of the soil and the amount of moisture as in respect to the altitude. The monotony of the grassy plain gives place to a veritable garden if but a few clay hummocks or stony points and ravines interrupt its interminable length. Seven thousand feet with one ex-

posure may produce a more truly Alpine flora than 9,000 feet with another.

Many species hold their own at almost all altitudes, and beginning with the lower altitudes, are successively in blossom throughout the season at higher and higher elevations. On the other hand, in given areas, a few certain plants are never met with except within a given range of elevation, but this given elevation differs for different parts of even the same state. It seems to be a relative point depending as much upon the elevation of the surrounding country as upon the actual elevation above sea-level. It follows, therefore, that plant zones can only be established for a given area, as for instance, the Laramie Plains and the mountains that rise on either hand of it.

It has been well pointed out by Dr. Coville in his report on the "Botany of the Death Valley Expedition" that only certain plants can be taken to mark zonal lines. That only a few comply with the two characteristics of a good zonal plant, viz: "It shall have a definite termination at the borders of a zone or at lines substantially parallel thereto, but closer together." "That the belt of a zonal plant should be continuous." In any region I think this may be found true of a very small number of plants, but the large majority which have to be fitted into these zones will so overlap from zone to zone that no sharp distinctions can be drawn. Of course, between the lowest and the highest zone of a given area the characteristics are quite distinctive. These represent essentially different floras with as little in common as the vegetation of the plains and that of the adjacent mountains.

In this report it has not seemed wise to try to estab-

lish the vertical zones on account of the comparatively limited observations yet made within the wide borders of a great state. Rather something may be said of certain areas or characteristic regions.

THE PLAINS FLORA.

The regions referred to as plains differ greatly in respect to soil, rainfall and altitude. All are comparatively level tracts of land devoid of arboreal vegetation, if one excepts the occasional border of Cottonwoods on stream banks. In this report no mention can be made of the plains of the north-eastern, nor of the south-western parts of the state, for these regions are yet to be visited. It is, however, well known that both these regions differ materially from the rest of the state and from each other. The former, with a considerable rainfall and "gumbo" soil; the latter, sandy soil and a minimum of rain. Careful exploration in these two regions will add a large number of species to the list of the state.

The plains from which we have reports, meagre as yet, are the Laramie Plains; the plains lying east of the Laramie Mountains, and south of Lusk; those bordering on the Platte River, and those northward from the Platte through the center of the state to Lander; the plains adjacent to Wind River, and those of the upper part of the Green River valley; also the Gros Ventre valley, and Jackson's Hole. Through this latter mountain-enclosed, plateau-like plain flows Snake River.

All of these may again be classified, either as a whole or in part as: 1. Sandy, or gravelly plains. 2. Alkali plains.

To the first class belong those whose soil is comparatively free from alkali and whose characteristic shrub,

when any is present, is the common sage brush (*Artemisia tridentata*). The characteristic undershrub is some form of *Bigelovia*, indiscriminately called White Sage, Rabbit Brush, Golden Rod, etc. Plains of this character may also be denominated grassy plains. The grasses on these of course vary greatly as to the species and the luxuriance of their growth. The following are among those of most frequent occurrence: *Agropyrum glaucum*, *A. violaceum*, *Bouteloua oligostachya*, and *B. racemosa*, *Buchloa dactyloides*, *Koeleria cristata*, one or two *Festucas* and several *Poas*. Along water courses and in boggy places, as well as in over-irrigated places, these are replaced or become mixed with many species of *Juncus*, *Scirpus* and *Carex*. Sometimes Foxtail (*Hordeum jubatum*) takes complete possession.

The second class.—The plains strongly impregnated with alkali (sodium carbonate or sodium sulphate), are in some instances nearly devoid of vegetation, but more usually we find several characteristic plants. If the alkali be sodium sulphate the characteristic shrub is *Sarcobatus vermiculatus*, the well-known Grease Wood. On sodium carbonate soil, this, if not replaced by, has mingled with it some form of *Atriplex*, usually *A. confertifolia*, frequently called White Sage. Other species of *Atriplex*, mostly annuals, are found in this character of soil, and if the soil is very strongly impregnated, as on the shores of salt-marshes and partially dried up alkali lakes, the various species of *Atriplex*, of *Sueda* and of *Salicornea* are often the only vegetation. In real alkali bogs we find *Distichlis maritima*, *Triglochin maritima* and *T. palustre* as the most characteristic vegetation.

The other areas may be spoken of as the foot-hills and the mountains.

FLORA OF THE FOOT-HILLS.

Two kinds of foot-hills must be recognized, viz: wooded and denuded. The denuded slopes are of course much dryer and a large part of the year devoid of all streams. These foot-hills, if stony or gravelly, are covered with *Cercocarpus parvifolius*, *Rhus tridentata*, *Amelanchier alnifolia*, *Purshia tridentata*—one or more in varying proportion. The intervening valleys, if soil is fertile, are usually covered with sage brush. The herbaceous vegetation in such foot-hills is so varied that no list can be offered here, but the following genera are well represented: *Draba*, *Astragalus*, *Potentilla*, *Actinella*, *Erigeron*, *Senecio*, *Krynitzkia*, *Phlox*, *Penstemon*, and *Poa*.

If the soil contains alkali, the above-mentioned shrubs give place to Grease Wood, and the herbaceous vegetation largely disappears.

The wooded foot-hills are less common, but they occur at intervals in the Laramie range, much more frequently in the Medicine Bow Mountains and the Wind River range. The arboreal vegetation consists of only a few species, unless one includes the Willows that skirt most of the streams that flow from the higher mountains. Lodge Pole Pine, Douglas Spruce, Rocky Mountain White Pine, Black Cottonwood (*Populus angustifolia*) and more rarely Blue Spruce, Engelmann's Spruce and Rydberg's Cottonwood (*Populus acuminata*) are the most frequently met with. The shrubs are more varied and include, besides those mentioned for the drier hills, *Juniperus*, *Prunus*, Willows and Quaking Asp. The latter in some places becomes a small tree and is in fact found at all altitudes along streams or on hill-sides below snow

banks. The smaller vegetation likewise includes a much greater number of species, each of which apparently strives for the mastery and produces the most beautiful confusion of forms.

THE MOUNTAIN FLORA.

Some of the mountain ranges are quite heavily timbered, notably the Medicine Bow and Wind River ranges. The Laramie Mountains are wooded only in part and some of these areas very sparsely. Other ranges are known to be wooded, but I speak only of those I have visited. The summits of the Laramie Mountains are mostly rounded and undulating, and on these we find a scattering growth of Rocky Mountain Yellow Pine (*Pinus ponderosa scopulorum*) and occasionally some straggling, stunted specimens of the Virginia Juniper. Wherever we find the range broken by more abrupt slopes, deeper canons and water courses, the arboreal vegetation assumes the character of a forest, and in some districts furnishes valuable lumber. This is the case at Laramie Peak and on some of the spurs that run out from it. The forests consist mostly of Douglas Spruce, Rocky Mountain White Pine and Lodge Pole Pine.

Much the larger part of the Medicine Bow Mountains are heavily wooded, and it is from these forests that the larger part of the native lumber used in the southern part of the state is obtained. About the same species prevail as in the Laramie Mountains, with the addition of the Blue Spruce and Engelmann's Spruce. The White Pine (*Pinus flexilis*) and Douglas Spruce form much the larger part of the whole. The latter, along the streams at the foot of the ranges, reaches its greatest size and it grad-

usually comes to form a larger proportion of the whole until at 9,000 feet and upward it constitutes practically an unbroken forest to the exclusion of other species. At timber line it becomes scattering, dwarfed and depressed, spreading out like a huge mat under the enormous pressure of the winter snows.

Practically the same conditions prevail in the Wind River Mountains, and probably, though I cannot speak from observation, in the Big Horn Mountains.

Of the fruticose and herbaceous vegetation I need not speak here, although the summits of these ranges yield many beautiful and strictly alpine forms. These all receive comment in their proper place in the list, so space may not be consumed for that purpose here.

THE TREES OF THE STATE.

A list of the trees of the state is indeed very short and were those on the border line between trees and shrubs excluded in would be shorter yet by a third.

Rocky Mountain Yellow Pine (*Pinus ponderosa scopulorum*).

Rocky Mountain White Pine (*Pinus flexilis*).

Lodge Pole Pine (*Pinus Murrayana*).

Engelmann's Spruce (*Picea Engelmanni*).

Blue Spruce (*Picea pungens*).

Douglas Spruce (*Pseudotsuga Douglasii*).

Virginia Juniper (*Juniperus Virginiana*).

Black Cottonwood (*Populus angustifolia*).

Rydberg's Cottonwood (*Populus acuminata*).

Quaking Asp, Aspen (*Populus tremuloides*).

Willow (*Salix longifolia*).

Willow (*Salix flavescens*).

Willow (*Salix amygdaloides*).

Willow (*Salix lasiandra*).

Green Ash (*Fraxinus viridis*).

Box Elder (*Negundo aceroides*).

-
- Scrub Oak (*Quercus undulata*)
 - Wild Plum (*Prunus Americana*).
 - Wild Cherry (*Prunus demissa*).
 - Wild Cherry (*Prunus Virginiana*).
 - Hawthorn (*Crataegus rivularis*).
 - Hawthorn (*Crataegus Douglasii*).
 - Service Berry (*Amelanchier alnifolia*).
 - (*Eleagnus argentea*).
 - Buffalo Berry (*Shepherdia argentea*).
 - Black Birch (*Betula occidentalis*).
 - Black Alder (*Alnus incana virescens*).
 - Sage Brush (*Artemisia tridentata*).

In a few localities of the state occasional specimens of Sage Brush attain a remarkable size—small trees in fact—so that a man on horseback may ride erect underneath the branches.

Other species have been reported but until the specimens are at hand they will not be listed. The number of shrubby plants is so great that to list them separately would be to reprint a large part of the succeeding systematic list.

THE FLORAS OF THE PACIFIC AND THE ATLANTIC SLOPES.

I have had no opportunity to compare the floras of the two regions except in so far as the plants on the western side of the Wind River range and those of Jackson's Hole and the Tetons, all of which are on the Pacific slope, may be compared with those on the eastern side of the Wind River Mountains and those of the south-eastern part of the state, which represent the Atlantic slope. Such examination has led to the conclusion that the continental divide, though dividing the waters, does not separate floras. The two regions have a far larger number

in common than they have of forms that are distinct. While my collection lists show much that is different, I firmly believe that the difference is due mainly to the season in which each was collected. I am confirmed in this by an examination of the lists given in Dr. J. M. Coulter's report on the Botany of the Hayden U. S. Geological Survey, 1872. These lists comprise those collected, 1. On both slopes; 2. Only on the eastern slope, and 3. Only on the western slope. Those of the last list were collected in the earlier part of the season, and a remarkable number are the same as those of my list for the eastern slope during the same months. Different localities and seasons yield different results, but complete collections would reveal no abrupt transitions; Iowa and Utah, for instance, have different floras, but any fifty or one hundred miles between, even at the summit of the Rockies, will show only the most gradual substitutions. One form disappears, a new one appears, but this occurs with a change of locality in any direction. On the plains of the Platte and its tributaries *Cleome integrifolia* only is found, while on Wind River and its tributaries *Cleome lutea* is the only form.

INTRODUCED PLANTS.

By introduced plants reference is made only to such as grow without cultivation. Most of them may properly be called "Weeds." This is an ever-growing list and will soon include a large part of those familiar to the eastern farmer. The extension of our agricultural interests of course includes the importation of seed, and rarely is any kind of seed free from weed seeds. Some of our weeds, however, are native plants and thrive immensely

under cultivation. Those of special interest receive notice in the proper place in the list, and possibly a future bulletin may deal with the weed problem in this state.

HARDINESS OF NATIVE PLANTS.

The power to withstand frost, so remarkably developed in mountain floras, has undoubtedly often been remarked upon before, but it is, nevertheless, unceasingly a cause of wonder. To see great beds of *Phlox*, *Mertensia*, *Gilia*, *Actinella* and scores of others in full bloom at times when the temperature at night is 5° to 20° F., below the freezing point is a phenomenon that can scarcely be explained. That reduced atmospheric pressure plays an important part in preventing injury, I think must be accepted, for the same plants at lower altitudes would perish. The following observation goes to prove this: Late in August in 1890, a plot of potatoes was noted in full blossom at Mountain Home, elevation about 9,000 feet. Observations on three successive days showed no trace of injury though on both of the intervening nights there were heavy white frosts and films of ice formed on water pails. Such a degree of cold would have absolutely killed potatoes at sea-level.

FLORAL CALENDAR.

In 1894 every effort was made to keep pace with the floral procession. At the altitude of the Laramie Plains, (7,000 feet), Spring opens comparatively late. April furnishes very few objects of interest to the botanist. The earliest flowers are *Phlox cæspitosa* and *Townsendia sericea*, both of which expand their blossoms scarcely above the surface of the ground. These are soon followed by

some small *Umbelliferae*, among which *Cymopterus montanus* may be noted. Toward the end of the month a few more begin to appear on the plains and in the foot-hills, all of which possess either large, fleshy, perennial roots, as *Leucocrinum montanum*, *Musenium trachycarpum* and *Peucedanum nudicaule*, or else they have large woody subterranean stems from which spring the small leaves and numerous flowers that spread out in dense mats or cushions upon the cold soil. Such are *Astragalus spatulatus* and *Astragalus sericoleucus*. Among the rocks in sheltered nooks are also two *Mertensias*, *lanceolata* and *alpina*. With the advent of May, or sometimes earlier, the little *Drabas*, *glacialis* and *alpina* tinge the naked rocks with yellow. In the moister canons our earliest Buttercup, *Ranunculus glaberrimus*, and the Wind-flower, *Anemone patens Nuttalliana*, are found.

Very slowly through May, for cold days and snow-storms are far from rare, the number grows so that the diligent observer may find several score. From this time on the forms crowd upon each other in rapid succession and one soon loses track of the order of their coming. June is the floral month of the plains, July of the lower mountains and August is the month of months in the high altitudes. September has something of worth everywhere and a few forms linger late into October.

BOTANICAL WORK IN THE STATE.

So far as I have been able to learn there are no other workers in systematic botany in the state, nor are there any other herbaria, public or private. On this account I have been unable to make comparison of our specimens with those from other localities in the state.

As before stated the following list is based wholly upon specimens in our herbarium. Plants reported as in the state are not included but appended in separate lists, each under heads showing by whom and from what locality reported.

NOMENCLATURE AND CITATIONS.

As the discussion of the nomenclature question is still waxing warm, happily with less acerbity than before, it has seemed almost a matter of indifference what view of the question was taken with reference to this report. Not that it is a matter of indifference to any worker in the field of botany, but the question seems so far from settlement that one may still expect almost any solution. Stability is the object all have in view and those who publish work of any kind will use that nomenclature which seems to them to offer the greatest chances for permanency. So long as different adherents of the so-called "new nomenclature" are far from agreed among themselves, as witness recent publications, there is small inducement to abandon a fairly satisfactory system. That there is room for improvement none will deny, but until there is international agreement we shall hardly reach a permanent, much less an ideal nomenclature.

I greatly regret that citations in many instances are quite incomplete. Meager library facilities must be my excuse.

Where the recent "List of Pteridophyta and Spermatophyta of the Northeastern United States" recommends a name, different from that used in this report, such name is given as a synonym without citation.

For the citations given I am often indebted to the

above list ; to recent publications from the Division of Botany, U. S. Dept. of Agriculture ; to various publications from the Gray Herbarium and to several other papers and reports.

CRYPTOGAMS.

In 1894 no Cryptogams were collected except a few Ferns. In 1895 efforts were made to secure the Mosses as well. No attention was given to the other groups but incidentally a few Lichens and Fungi were picked up. In future collecting it is purposed to give more attention to this part of the flora.

ACKNOWLEDGEMENTS.

I have pleasure in acknowledging the generous assistance of the various members of the collecting party of 1894. To Prof. W. C. Knight I am indebted for specimens and information in the field and subsequently for literature and data upon various topics. The services rendered by Prof. B. C. Buffum in the field I have previously mentioned ; his continued interest and occasional assistance is greatly appreciated. To Mrs. Celia A. Nelson much credit is due for her painstaking care in the preparation of specimens and her devotion to the work during the expeditions of 1895. The task of putting this manuscript in shape for the printer is work for which I am also largely indebted to her.

For assistance in the determination of certain groups I am greatly indebted to the following specialists: To Dr. B. L. Robinson, to whom a considerable number were submitted for comparison and determination. For careful reports upon these I am indebted to him and Mr. M. L. Fernald. Certain orders and genera were sub-

mitted only in part as follows: *Astragalus* to Prof. E. P. Sheldon; *Umbelliferae* to Dr. J. N. Rose; *Juncus* to Dr. F. V. Coville; *Gramineae* to Dr. F. Lamson-Scribner; *Carex* to Prof. L. H. Bailey; *Salix* to the late Mr. M. S. Bebb; *Filices* to Prof. L. M. Underwood; *Musci* to Prof. J. M. Holzinger; *Fungi* to Mr. J. B. Ellis; *Lichens* to Dr. J. W. Eckfelt. Lastly I would mention the kindness of Prof. E. L. Greene, who has furnished determinations, corrections and valuable suggestions on a number of miscellaneous specimens.

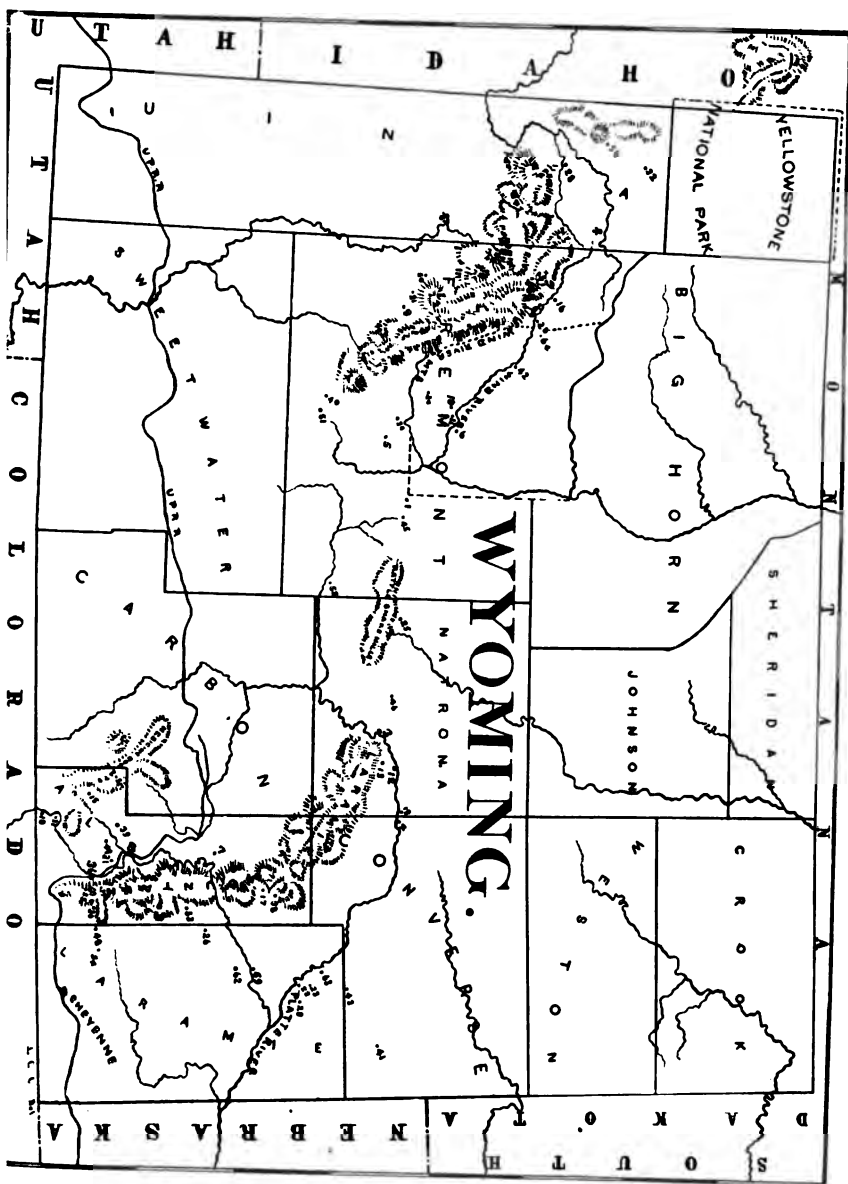
EXPLANATIONS.

All comments upon plants, such as rare, frequent, etc., refer to this state and in particular to those parts of the state which this report covers. The number in parenthesis following the comments upon each species is the collection number and will render reference to the specimens easy in case any are found incorrectly determined.

PRINCIPAL CAMPS AND COLLECTING LOCALITIES.

The following table contains the principal points in the neighborhood of which most of the material was secured. The altitudes given are only approximate and for hills, mountains, etc., the extremes may be less or greater than given.

NO.	PLACE.	COUNTY.	ELEVATION—FT.
1.	Alkali Springs	Fremont.	5500
2.	Bacon Creek	Uinta	7000-8000
3.	Bessemer	Natrona.	5300
4.	Big Muddy Creek	Converse.	5000
5.	Big Popo Agie River	Fremont	5300
6.	Big Wind River	Fremont	5300
7.	Blue Grass Creek	Albany	6000-7000
8.	Blue Grass Hills	Albany	6500
9.	Boulder Creek	Fremont	7400
10.	Bull Lake	Fremont	5350
11.	Bull Lake Creek	Fremont	5300
12.	Casper	Natrona,	5200
13.	Casper Mountain	Natrona	5500-6500
14.	Centennial Hills	Albany	8000-9500
15.	Centennial Valley	Albany	7500-8000
16.	Clark's Ranch	Fremont.	7300
17.	Cottonwood Canon	Albany	6000-6500
18.	Cummins, vicinity of	Albany	8000-9000
19.	C. Y. Ranch	Converse.	5000
20.	Dubois	Fremont	7000
21.	East Fork	Fremont	7300
22.	Fairbanks	Laramie	4300
23.	Ford J. Ranch	Laramie	4500
24.	Fort Washakie	Fremont	5300
25.	Garfield Peak	Natrona	6000-8000
26.	Grant	Laramie.	6000
27.	Green River	Uinta	8000
28.	Gros Ventre River	Uinta	7000
29.	Hartville	Laramie	4500
30.	Horse Creek	Albany	7300-7800
31.	Howell Lakes	Albany	7000
32.	Jackson's Hole	Uinta	6500
33.	Jelm' Mountain	Albany..	8000-9000
34.	Lander	Fremont	5300
35.	La Plata Mines	Albany	11000
36.	Laramie	Albany	7300
37.	Laramie Hills	Albany	7500-8500
38.	Laramie Peak	Albany	7000-9000
39.	Laramie Plains	Albany	7000
40.	Little Sandy	Fremont.	7000
41.	Lusk	Converse.	5000
42.	Meadow Creek	Fremont	6500
43.	Mexican Mines	Converse.	4750
44.	Muddy Creek	Fremont	7000
45.	Musk-rat Creek	Fremont	5500
46.	Platte River	Laramie	4200
47.	Poison Spider Creek	Natrona	5500-6000
48.	Pole Creek	Albany	7000-8000
49.	Seven-mile Lake	Albany	7000
50.	Silver Creek	Fremont	7000
51.	South Pass City	Fremont	7500
52.	Sweetwater River	Fremont	6000-7000
53.	Syblle Creek	Albany	6000-7000
54.	Table Mountain	Laramie.	7000-8000
55.	Telephone Canon	Albany	7500-8000
56.	Teton Mountains	Uinta	7000-11000
57.	Union Pass	Fremont.	8000-10000
58.	Union Peak	Fremont	10000-11000
59.	Uva	Laramie	4500
60.	Warm Spring Creek	Fremont	5000
61.	Whalen Canon	Laramie	4750
62.	Wheatland	Laramie.	4700
63.	Willow Creek	Laramie	4500
64.	Wind River, North Fork of	Fremont	6500





LIST OF SPECIES.

RANUNCULACEÆ.

Clematis ligusticifolia, Nutt. Torr. & Gray, Fl. i, 9 (1838).

From type locality, viz: "Plains of the Rocky Mountains, in open and in bushy places near streams." Rather frequent.

Blue Grass Creek, Fl. July 8, 1894 (No. 361); Popo Agie River, Fr. August 3, 1894 (No. 712). *Virgin's Bower*.

Clematis Douglasii, Hook. Fl. Bor. Am. i, 1 (1829).

Observed only in one locality, on open hillside.

Laramie Hills, June 9, 1894 (No. 202).

Clematis verticillaris Columbiana, M. E. Jones.

Infrequent, on moist wooded hillsides.

Pole Creek, May 25, 1894 (No. 72).

Thalictrum Fendleri, Engelm. Gray Pl. Fendl. 5.

Common in wet Meadows.

Horse Creek, June 9, 1894 (No. 189); East Fork, August 25, 1894 (No. 1119). *Meadow Rue*.

Thalictrum occidentale, Gray. Proc. Am. Acad. viii, 372.

In thickets along mountain streams, variable as to number of akenes which sometimes are 7-12.

Jackson's Hole, August 20, 1894 (No. 937); Gros Ventre, August 25, 1894 (No. 1067).

Thalictrum purpurascens, L. Sp. Pl. 1753.

Found but once, probably confined to the north and east.

Whalen canon, July 17, 1894 (No. 512);

Thalictrum sparsiflorum, Turcz. in Ind. Sem. Petr. i, 40.

On mountain streams, 8000 ft. and upward.

Cummins, July 30, 1895 (No. 1494).

Anemone cylindrica, Gray, Ann. N. Y. Lyc. iii, 221.

Not common, in fertile valleys, near streams.

Laramie Peak, August 5, 1895 (No. 1583).

Anemone multifida, Poir, Suppl. i, 364.

Intrequent, moist mountain valleys.

Laramie Hills, June 22, 1894 (250), B. C. Buffum; Upper Wind River, August 10, 1894 (No. 756).

Anemone patens Nuttalliana, Gray, Man. Ed. 5, 36 (1867). *Pulsatilla hirsutissima*. (Pursh) Britton.

One of the earliest flowers, on moist, rich canon-sides.

Laramie Hills, Fl. May 4, 1894 (No. 2); Fr. May 29. *Wind Flower*.

Anemone Pennsylvanica, L. Mant. ii, 247. *A. Canadensis*, L.

Very abundant on streams in the eastern part of the state.

Pole Creek, June 2, 1894 (No. 139); Sybille Creek, July 8, 1894 (No. 406).

Ranunculus acrifolius, Gray, Proc. Am. Acad. xxi, 374.

Common on creek and river bottoms, at least in Albany county.

Horse Creek, June 9, 1894 (No. 199); Little Laramie River, June 9, 1895 (No. 1306). *Buttercup*.

Ranunculus affinis cardiophyllus, Gray, Proc. Acad. Phila. 56 (1863).

This seems to be a good variety, easily distinguished from var. *validus*, Gray, by the smaller size of the plant, and by the thinner leaves which are either somewhat acute or show a tendency to become divided. Mountain meadows at 7000-8000 ft. Pole Creek, June 2, 1894 (No. 126).

Ranunculus affinis validus, Gray.

Wet meadows, Horse Creek, June 9, 1894 (No. 195).

Ranunculus alismæfolius, Geyer. Benth. Pl. Hartw. 295 (1839).

This is not quite typical and is probably var. *montanus*, Watson. or *R. alismellus*, Greene. Medicine Bow Mountains, at 11,000 ft. August 23, 1895 (No. 1762).

Ranunculus aquatilis trichophyllus, Gray, Man. Ed. 5, 40 (1867). *Batrachium trichophyllum*, (Chaix) Bossch.

Common in slow-moving streams. Muddy Creek, August 25, 1894 (No. 1112).

Ranunculus Oymbalaria, Pursh, Fl. Am. Sept. 392 (1814). *Cyrtorhyncha Cymbalaria*, (Pursh) Britton.

Very common in wet alkali soils. Laramie, at various times, the plant remaining in blossom throughout the season; Lander, August 3, 1894 (No. 693).

Ranunculus Eschscholtzii, Schlecht. *Animad. Ranunc.* ii, 16.

Union Peak, August 13, 1894 (No. 1003); Medicine Bow Mountains, at 11,000 ft., August 22, 1895 (No. 1780).

Ranunculus eximius, Greene, *Erythraea* iii, 19 (1895).

A most beautiful large-flowered species collected by B.C. Buffum at Bald Mountain, August 15, 1892. The specimens in our herbarium are in part the ones from which the original description was drawn.

Ranunculus flammula reptans, Mey. *Pl. Lab.* 96 (1836). *R. reptans*, L.

Not common, creeping among the stones on the shore of Bull Lake Creek, August 9, 1894 (No. 729).

Ranunculus glaberrimus, Hook. *Fl. Bor. Am.* i, 12, t. 5.

Our specimens are the form represented by Prof. Greene's *R. ellipticus*, Pittonia, ii, 110. Our earliest Buttercup; very abundant among the sage brush in moist valleys; Laramie Hills, April and May, 1894 (No. 3).

Ranunculus Macounii, Britton, *Trans. N. Y. Acad. Sci.* xii, 3 (1892).

Frequent on low-lying wet lands; Big Wind River, August 9, 1894 (No. 723); Cummins, July 29, 1895 (No. 1483).

Ranunculus natans, C. A. Mey. in *Ledeb. Fl. Alt.* ii, 315.

In the mountains, on the muddy banks or in the water of partially dried up lakes. Union Pass, August 10, 1894 (No. 808); East Fork, August 27, 1894 (No. 1113).

Ranunculus Nuttallii, Gray, *Proc. Acad. Phila.* 56 (1863). *Cyrtorhyncha ranunculina*, Nutt.

Very abundant on rocky ridges at 8,000-9,000 ft. Laramie Hills, May and June, 1894 and 1895 (Nos. 76 and 1237).

Ranunculus Purshii, Richards. *Frank. Journ.* 741 (1823).

In the bed of a recently dried up lake, Union Pass, August 14, 1894 (No. 880).

Ranunculus rhomboides, Goldie. *Edinb. Phil. Journ.* vi, 329 (1822).

R. ovalis, Raf.

Rare, observed only in wet meadows on Pole Creek, May 25, 1894 (No. 78).

Ranunculus sceleratus, L. *Sp. Pl.* 551 (1753).

Abundant in shallow spring pools; Fairbanks, July 14, 1894 (No. 453).

***Oaltha leptosepala*, D. C. Syst. i, 310.**

Very abundant in wet grounds at 9,000-10,000 ft., greedily eaten by elk and locally called "Elk Slip." Union pass, August 13, 1894 (No. 1023).

***Trollius latus*, Salisb. Trans. Linn. Soc. viii, 303 (1803).**

In the mountains at 9,000 ft. and upward. Union Pass, August 14, 1894 (No. 886); Medicine Bow Mountains, August 22, 1895 (No. 1709).

***Aquilegia cœrulea*, James. Long's Exped. ii, 345.**

The queen of Columbines, superbly handsome. In the woods at 8,000-10,000 ft. Laramie Hills, June 22, 1894 (No. 249), B. C. Buffum.

***Aquilegia cœrulea alpina*, n. var.**

This, it seemed to me, must be *A. pubescens*, Coville, but Dr. Robinson thinks it is rather a form of *cœrulea*. Further examination convinces me that this is right. It is hardly Dr. Gray's var. *albiflora*, for these specimens are all distinctly yellow and in habitat strictly alpine. The variety differs from the species in the smaller size of the plant and larger leaves with upper leaflets entire; in the smaller flowers and very much shorter spurs.

Possibly confined to the Wind River Mountains, where it occupies crevices and ledges of the naked summits above timber line. Observed by Prof. B. C. Buffum, in such locations in 1892 and collected by the writer on Union Peak at 10,500 ft., August 13, 1894 (No. 894).

***Aquilegia Laramiensis*, n. sp.**

Many stemmed from a rather large, semi-fleshy root; 6-9 inches high. The stems and petioles inclined to be decumbent and diffuse. Spurs short, hooked and knobbed. Slightly pubescent on the underside of leaves, on flowers, follicles and pedicels. Sepals greenish white, lanceolate with emarginate apex; lamina, of the light cream-colored petals, obtuse elliptical, longer than the spur.

It differs from *A. saximontana* in its greater pubescence and larger leaflets; from *A. brevistyla* in having longer petioles with dilated bases; from *A. flavescens* in habit and especially in habitat.*

*I am indebted to Dr. Robinson for making comparison of this with the nearly related species.

Collected at the foot of Laramie Peak, in the Laramie range, in a canon where it occupied the dry crevices in abrupt cliffs.

Delphinium azureum (?) Michx. Fl. Bor. Am. i, 314 (1803). *D. Carolinianum*, Walt.

Not quite typical but probably a form of this species. Saratoga, June 1893. J. D. Parker.

Delphinium bicolor, Nutt. Journ. Acad. Phila. vii, 10.

Our earliest Larkspur, in dry loam soil of ravines and hillsides.

Telephone Canon, May 23, 1894 (No. 48); Table Mountain, June 28, 1895 (No. 1385).

Delphinium Geyeri, Greene.

A good species, immensely abundant on the Laramie Plains. Frequently greedily eaten by hungry cattle with fatal results, caused by bloating, hence the local common name, "Poison Weed." Laramie Hills, July 10, 1894 (No. 400); South Laramie Plains, July 31, 1895 (No. 1552).

Delphinium scopulorum glaucum, Gray. Bot. Gaz. xii, 52. *D. glaucum*, Wats.

In the mountains at 8,000-9,000 ft.; Union Pass, August 10, 1894 (No. 874); Laramie Peak, August 7, 1895 (No. 1599).

Delphinium scopulorum subalpinum, Gray. Bot. Gaz. xii, 52.

A very beautiful alpine form. LaPlata Mines, 11,000 ft., August 22, 1895 (No. 1761).

Aconitum Columbianum, Nutt. T. & G. Fl. i, 34.

Two marked forms occur: The typical one, tall, large-leaved and dark blue or purple flowered; the other, repeatedly observed, has light yellow flowers, the plant is smaller, leaves smaller and less pubescent. Less striking differences have sometimes been held to be specific, so it seems proper that this at least bear the varietal name *ochroleucum*. The former is common in thickets on mountain streams. Collected at Snake River, August 21, 1894 (No. 939); Cummins, July 29, 1895 (No. 1521). • The latter, less frequent, in similar locations; collected at Cummins and in Centennial Valley and observed at Laramie Peak.

Actea spicata arguta, Torr. Pacif. R. Rep. iv, 63.

White and red berried forms occasionally found growing together. Garfield Peak, July 29, 1894 (Nos. 681 and 692); Cummins July 27, 1895 (No. 1490).

BERBERIDACEÆ.

Berberis Repens, Lindl. Bot. Reg. t. 1176 (1828).

Common among the rocks in hilly regions. Laramie Hills, May 25, 1894 (No. 66); Centennial Hills, August 1895.

NYMPHÆACEÆ.

Nuphar polysepalum, Engelm. Trans. St. Louis Acad. ii, 283 (1865).

Nymphaea polysepala, (Engelm.) Greene.

Sub-alpine ponds and lakes, not common.

Medicine Bow Mountains, by Col. S. W. Downey; Union Pass, August 14, 1894 (No. 898). *Yellow Pond Lily*.

PAPAVERACEÆ.

Argemone platyceras. Link & Otto, Icon. i, 85, t. 43 (1828). *Argemone albiflora*, Hornem.

Common on the eastern slopes of the Laramie Hills.

Chugwater Station, B. C. Buffum, July 14, 1891; Sybille Hills, July 8, 1894 (No. 314); Table Mountain, July 1, 1895 (No. 1363). *Poppy*.

FUMARIACEÆ.

Corydalis aurea, Willd. Enum 740 (1809). *Capnoides aureum*, (Willd) Kuntze.

This and the following occurs frequently in dry sandy ravines and on the adjoining hillsides.

Centennial Valley, August 19, 1895 (No. 1679).

Corydalis aurea occidentalis, Engelm.

The variety is far more common than the species.

Telephone Canon, June 3, 1894 (No. 118); Laramie, June 5, 1895 (No. 1241).

CRUCIFERÆ.

Nasturtium obtusum, Nutt. T. & G. Fl. N. A. i, 74 (1838). *Roripa obtusa* (Nutt.) Britton.

Usually found growing in spray of miniature waterfalls.

East Fork, August 25, 1894 (No. 1116); Pole Creek, July 2, 1895 (No. 1415).

Nasturtium officinale, R. Br. in Ait. Hort. Kew. Ed. 2, iv, 110 (1812).

Roripa Nasturtium. (L.) Rusby.

Not common, but introduced into some of the springs about Laramie and probably elsewhere in the state.

State Fish Hatchery, September 24, 1894 (No. 1152). *Water Cress*.

Nasturtium palustre, DC Syst. Veg. ii, 191 (1821). *Roripa palustris*, (L.) Bess.

Only rarely seen, wet lowlands.

C. Y. Ranch, on Big Muddy, July 24, 1894 (No. 638).

Nasturtium palustre hispidum, Fisch & Mey. Ind. Sem. Petr. iii, 41. *Roripa hispida* (Desv.) Britton.

This was found twice but only a specimen or two at a time.

Sybill Creek, July 9, 1864 (No. 300.); South Pass, September 2, 1894 (No. 1185).

Nasturtium sinuatum, Nutt. T. & G. Fl. N. A. i, 73 (1838). *Roripa sinuata*, (Nutt.) A. S. Hitchcock.

Apparently quite common, a weed on the campus and on the Experiment farm. (No. 281).

Nasturtium sp.?

A single specimen collected by B. C. Buffum at Bald Mountain, no fruit. Its affinities are not readily made out at this stage but evidently is none of the above.

Barbarea vulgaris, R. Br. in Ait. Hort. Kew. Ed. 2, iv, 109 (1812).

B. Barbarea, (L.) Mac M.

Union pass, August 10, 1894 (No. 864); Stout plants, thick pods but otherwise normal.

Arabis.

(For this and a few other genera see appendix.)

Thelepodium. (See appendix.)

Cardamine Breweri, Watson, Proc. Am. Acad. x, 339.

Common, at the water's edge in many of our streams. Pole Creek, June 2, 1894 (No. 158); Cummins, July 28, 1895 (No. 1465).

Cardamine cordifolia, Gray, Pl. Fendl. 8.

On stream banks in mountain thickets, quite infrequent. Cummins, July 27, 1895 (No. 1488).

Cardamine Pennsylvanica, Muhl. Sp. Pl. 3: 486 (1800).

Found but once, Lander Creek, August 30, 1894 (No. 1106).

Lesquerella Ludoviciana, Watson, Proc. Am. Acad. xxiii, 252 (1888).

Vesicaria Ludoviciana, D. C.

Remarkably abundant on the Laramie Plains, in dry sandy soil.
June 1, 1894 (No. 190).

Lesquerella montana, Watson, l. c. 251. *Vesicaria montana*, Gray.

Very abundant on the sandy, stony foothills of the Laramie range. Table Mountain June 2, 1894 (No. 88); Pole Creek, June 30, 1895 (No. 1370).

Physaria didymocarpa, Gray, Gen. Ill. i. 162 (1848).

In gravelly clay banks, infrequent, not readily distinguished from *Lesquerella* until the pods begin to mature. Gros Ventre River, August 16, 1894 (No. 927); Cummins, July 30, 1895 (No. 1555).

Draba. (See appendix.)

Draba alpina, L. Sp. Pl. ii, 642 (1753).

Abundant, on stony gravelly ridges on the plains and in the foothills. Laramie Hills, May 4, 1894 (No. 4); Laramie River Divide, June 9, 1895 (No. 1223).

Draba crassifolia, Graham, Edinb. New Phil. Journ. 182 (1829).

Infrequent, damp, shaded ground; LaPlata Mines, August 21, 1895 (No. 1838).

Draba glacialis, Adams, Mem. Soc. Nat. Mosc. v, 106.

Frequent and of similar habitat as *D. alpina*. Maturing fruit early in May. (Nos. 62 and 1218).

Draba stenoloba, Ledeb. Fl. Ross. i, 154 (1841).

Very rare, collected by B. C. Buffum, in a gulch near Bald Mountain, August 15, 1892.

Sisymbrium canescens, Nutt. Gen. ii, 68.

As variable as it is frequent in occurrence. Table Mountain, June 30, 1895 (No. 1321); Laramie, June 16, 1894 (No. 247).

Sisymbrium incisum, Engelm. Gray Pl. Fendl. 8.

Difficult to separate from some of its varieties. Wheatland, July 9, 1894 (No. 475); South Pass, August 31, 1894 (No. 1184).

Sisymbrium incisum filipes, Gray, Pl. Fendl. 8.

Not at all common; Laramie, August 1893; near Table Mountain, June 30, 1895 (Nos. 1349 and 1425).

Sisymbrium incisum Hartwegianum, Wats, Bot. cal. i, 41.

Observed but once; Sand Creek, August 26, 1894 (No. 1100).

Sisymbrium linifolium, Nutt. T. & G. Fl. i, 91.

Abundant and of frequent occurrence on the plains and in the foothills. Laramie, June 12, 1894 (No. 173); June 1895 (No. 1420).

Smelowskia calycina, C. A. Meyer, Ledeb. Fl. Alt. iii, 165.

Very rare, found but once and then but a plant or two; Laramie Hills, June 1893.

Erisymum asperum Arkansanum, Gray, Man. Ed. 5, 69.

This variety is of very frequent occurrence; in early summer it forms a very conspicuous object on the sandy plains and hillsides in Albany county. Table Mountain, June 2, 1894 (No. 87); Two Bar Ranch on Blue Grass Creek, July 9, 1894 (No. 377).

Erisymum cheiranthoides, L. Sp. Pl. 661 (1753).

Widely distributed but not particularly abundant; Sybille Creek, July 8, 1894 (No. 404); South Pass, September 1, 1894 (No. 1187), and Cummins, July 30, 1895 (No. 1462).

Erisymum parviflorum, Nutt. T. & G. Fl. N. A. i, 95 (838.) *E. inconspicuum*. (Wats.) MacM.

Frequent; Laramie, June 20, 1894 (No. 221); Bacon Creek, August 15, 1894, (No. 916).

Stanleya pinnatifida, Nutt. Gen. ii, 71 (1818). *S. pinnata*, (Pursh) Britton.

Only occasionally, on dry gravelly banks; Little Laramie River, June 6, 1894, by Mr. Houghton; Wood's Landing, July 31, 1895 (No. 1554).

Stanleya pinnatifida integrifolia, Robinson, Syn. Fl. i, 179 (1895).

This form much less common; stems numerous from a large deep-set root; on the dry plains west of Laramie, August 26, 1895 (No. 1845).

Stanleya viridiflora, Nutt. T. & G. Fl. i, 98.

Very rare, not found at all by the writer; collected at Wheatland, June 16, 1892, B. C. Buffum.

Brassica campestris, L. Sp. Pl. 666 (1753).

Occasionally seen in waste places about town; Laramie, September 15, 1893.

Brassica napistrum, Boiss. Voy. Espagne, ii, 39 (1839-45).

A single specimen from Centennial Valley, August 25, 1895 (No. 1876).

Capsella Bursa-Pastoris, Medic. Pfl. Gatt. i, 85 (1792). *Bursa Bursa-Pastoris*, (L.) Weber.

A weed in lawns and dooryards everywhere; University Campus, June 1891.

Lepidium apetalum, Willd. Spec. iii, 439.

Quite common on the Laramie Plains, in some places becoming a weed.

Blue Grass Hills, July 8, 1894 (No. 323); University Campus, July 22, 1895 (No. 1424).

Lepidium montanum, Nutt. T. & G. Fl. i, 116, 669.

Rare, State Fish Hatchery grounds, Laramie, B. C. Buffum, 1892; Carbon, June 18, 1894 (No. 257), Miss Lily Boyd.

Lepidium Virginicum, L. Sp. Pl. 645 (1753).

Occasionally found introduced into lawns and vacant lots. Laramie, June 15, 1891, B. C. Buffum.

Thlaspi alpestre, L. Sp. Pl. ii, 903.

The typical form of this species is abundant in the Laramie Hills on open hillsides at 7,000-8500 ft. Telephone Canon, May 21, 1891, B. C. Buffum; Pole Creek, May 12, 1894 (No. 28).

Thlaspi alpestre glaucum, n. var.

The perennial basal part of stem rather freely branched, herbaceous stems simple and erect, 6-10 inches high; radical leaves broadly to narrowly elliptical, entire or obscurely repand-denticulate; cauline deltoid-auriculate entire. It also differs from the species in the glaucous hue of the leaves, the laxer inflorescence and well marked notch at the apex of the capsule as well as in its habitat. The species flowers in early spring on open hillsides; the variety was collected in the forest almost at timber line, growing in the thick beds of Spruce needles. La Plata Mines, August 21, 1895 (No. 1777).

CAPPARIDACEÆ.

Oleome integrifolia, T. & G. Fl. i, 142.

An obnoxious weed, sometimes occupying acres of ground to the exclusion of everything else. Everywhere on the Laramie plains, and, in fact, all over the south-eastern part of the state. Laramie, June 24, 1894 (No. 297).

Oleome lutea, Hook. Fl. Bor. Am. i, 70, t. 25.

This seems to replace the preceding on the Wind Rivers and in the north-west generally; in sandy soil. Big Wind River, August 5, 1894 (No. 701).

Polanisia trachysperma, T. & G. Fl. N. A. i, 669 (1840).

Widely distributed in the state but not very abundant; on sandy banks. Laramie Plains July 10, 1894 (No. 333); and B. C. Buffum, at Wheatland.

VIOLACEÆ.

Viola blanda, Willd. Hort. Berol. t, 24 (1806).

Quite rare, on mossy bank in the light spray of a little waterfall. Centennial Hills, June 9, 1895 (No. 1257).

Viola Canadensis, L. Sp. Pl. 936 (1753).

Abundant in thickets along streams.

Head of Pole Creek, May 25, 1894 (No. 44); Near Table Mountain, July 2, 1895 (No. 1406).

Viola canina adunca, Gray, Proc. Am. Acad. viii, 377,

Occurs less frequently than the following, leaves less crowded on the rootstock.

Pass Creek June 20, 1892, B. C. Buffum; Horse Creek, June 9, 1894 (No. 209).

Viola canina Muhlenbergii, Traut. Act. Hort. Petrop. v, 28.

Widely distributed, rather abundant and variable.

Pole Creek June 2, 1894 (No. 146); Centennial Valley, June 9, 1895 (No. 1284).

Viola Nuttallii, Pursh, Fl. Am. i, 174 (1814).

The earliest and commonest Violet on the plains.

Laramie, May 19, 1894 (No. 37); May 23 1895 (No. 1229).

Viola palmata cucullata, Gray, Bot. Gaz. xi, 254 (1886).

Infrequent. Horse Creek, June 9, 1894 (No. 191).

Viola palustris, L. Sp. Pl. ii, 934 (1753).

A beautiful little plant observed but once, on a boggy bank.

Pole Creek, June 2, 1894 (No. 140).

Viola præmorsa, Dougl. Lindl. Bot. Reg. i, 1254.

This must be very rare in the state and its occurrence here extends its range considerably. Observed both in 1894 and in 1895, only at the head of Pole Creek, May, (Nos. 43 and 1215).

CARYOPHYLLACEÆ.

Saponaria Vaccaria, L. Sp. Pl. 409 (1753).

This is becoming a troublesome weed in some parts of the state.

From the Big Horn Mountains, by B. C. Buffum in 1892; Wheatland, July 11, 1894 (No. 474).

Silene acaulis, L. Sp. Pl. ii, 603 (1762).

Strictly alpine, Teton Mountains, August 21, 1894 (No. 973);

Medicine Bow Mountains, August 22, 1895 (No. 1828),

Silene antirrhina, L. Sp. Pl. 419 (1753).

Widely distributed and not rare. Platte River, July 14, 1894 (No. 493); Centennial Valley, August 17, 1895 (No. 1658).

Silene Douglasii multicaulis, Robinson, Contr. Gray, Herb. 144 (1893).

Union Pass at 10,000 ft., August 13, 1894 (No. 1019).

Silene Douglasii viscosa, Robinson, l. c. 145.

This is not quite typical but Dr. Robinson thinks it too near to be separated. Union Pass, August 11, 1894 (No. 845).

Silene Hallii, Watson, Proc. Am. Acad. xxi, 446.

On grassy, open slopes at high elevations; LaPlata Mines, August 21, 1895 (No. 1829).

Agrostemma Githago, L. Sp. Pl. 435 (1753).

As yet very rare in the state. Collected at Sugg's Road by B. C. Buffum August, 1891.

Cerastium alpinum Behringianum, Regel. Ost. Sib. i, 435.

Not common even in the mountains; Union Peak, August 13, 1894 (No. 1013).

Cerastium arvense, L. Sp. Pl. 438 (1753).

Very abundant in early summer in the Laramie Hills. Pole Creek, June 2, 1894 (No. 138); near City Springs, June 21, 1891. B. C. Buffum.

Cerastium arvense latifolium, Fenzl. Ledeb. Fl. Ross. i, 412.

Frequent on rocky hills and ledges in the mountains; Laramie Hills, May 24, 1894 (No. 41).

Cerastium arvense maximum, Hollick and Britton, Bull. Torr. Club. xiv, 45.

Apparently rare; near the creek bank on lower Pole Creek, July 1, 1895 (No. 1380).

Cerastium nutans, Raf. Prec. Dec. 36 (1814). *C. longipedunculatum* Muhl.

Collected only in the north-western part of the state; Bacon Creek, August 16, 1894 (No. 924).

Stellaria borealis, Bigel, Fl. Bost. Ed. 2. 182 (1824). *Alsine borealis*, (Bigel.) Britton.

Infrequent; Centennial Valley, August 18, 1895 (No. 1738).

Stellaria longifolia, Muhl. Willd. Enum. 479. *Alsine longifolia*, (Muhl) Britton.

Abundant in wet places along streams; near Table Mountain, July 2, 1895 (No. 1417).

Stellaria longifolia laeta, T. & G. Bibl. Index. 112.

Rare; observed but once, LaPlata Mines, August 21, 1895 (No. 1774).

Stellaria longipes, Goldie, Edinb. Phil. Journ. vi, 327. *Alsine longipes*, (Goldie) Coville.

The commonest of the Chickweeds in Wyoming. Horse Creek, July 11, 1891, B. C. Buffum; Laramie, June 30, 1894 (No. 286). Lander, August 4, 1894 (No. 713).

Stellaria umbellata, Turcz. Cat. Baic. 5.

Frequent in the Mountains at 9,000 to 11,000 ft.; Union Pass, August 13, 1894 (No. 992); LaPlata Mines, August 21, 1895 (No. 1809).

Arenaria congesta, Nutt. T. & G. Fl. i, 178.

In open and in grassy places on hills and in the mountains everywhere; immensely abundant; Little Bald Mountain, August 15, 1892, B. C. Buffum; Laramie Hills, July 7, 1894 (No. 357).

Arenaria congesta subcongesta, Watson, Bot. Cal. i, 60.

Infrequent; only at high altitudes; on the Grand Teton, at 10,000 ft., August 21, 1894 (No. 1059).

Arenaria Fendleri, Gray, Pl. Fendl. 13.

This, like *A. congesta*, is found everywhere in the hills and mountains, in dry open rather than shaded ground. Laramie Hills, July 7, 1894 (No. 353).

Arenaria Hookeri, Nutt. T. & G. Fl. N. A. i, 178 (1838).

This is of very frequent occurrence both on the plains and in the mountains. Somewhat variable in general appearance; that on the plains short and forming large mats; that in the hills growing

in the Pine needles in the shade less, cæspitose and of ranker growth. Laramie, June 20, 1894 (No. 225); Wind River Mountains, August 11, 1894 (No. 856); Laramie Peak, August 7, 1895 (No. 1595).

***Arenaria Sajanensis*, Willd. Schlecht. Berl. Mag. Natf. 200 (1816).**

This plant collected at almost the opposite extremes of the state seems to confine itself to the naked alpine summits. Union Peak, August 13, 1894 (No. 1009); La Plata Mines, August 22, 1895 (No. 1826).

***Arenaria* sp. (See appendix).**

***Tissa sparsiflora*, Greene, Erythea, iii, (1895).**

This recently described species seems to have a very circumscribed range. It was first observed in the autumn of 1894, when it was collected by the writer in a wet meadow, some seven miles from Laramie, in a soil strong with alkali, receiving seepage water from an irrigation ditch. A very rank growth, resulting in long, lax and sparsely flowered stems had been attained. Observations upon it in 1895 in the same and other localities show that, under normal conditions, it grows to only 3-8 inches in height; that it is nearly erect, but freely branched from the base. This shortening of the stems shows the flowers to be numerous in proportion to the size of the plant and makes the specific name hardly characteristic. In the original description the observation is made that it is the first *Tissa* reported from the interior of the continent. Observed only about Laramie and in low alkali ground. Seven Mile Lake, October 15, 1894 (No. 1158); Laramie, September 3, 1895 (No. 1868).

PORTULACACEÆ.

***Portulaca oleracea*, L. Sp. Pl. 445 (1753).**

Becoming introduced in some localities; from Sheridan Expt. Farm, by the superintendent, J. F. Lewis, September 1895.

***Calandrinia pygmæa*, Gray, Proc. Am. Acad. viii, 623.**

A beautiful little plant of alpine habitat. Union Peak, August 13, 1894 (No. 1015); La Plata Mines, August 20, 1895 (No. 1778).

***Claytonia Caroliniana sessilifolia*, Torr. Pac. R. Rep. iv, 70 (1856).**

Common on hillsides in rich, damp soil. Laramie Hills, May 12, 1894 (No. 27); Pole Creek, May 18, 1895 (No. 1219).

Claytonia sp.?

This may be a reduced alpine form of the preceding. The whole plant is small, 1-2 inches high, raceme reduced to one or two flowers and the leaves more acutely lanceolate. Collected on the shores of a lake at 9,000 ft. on the Grand Teton, August 21, 1894 (No. 1061).

Claytonia Ohamissonis, Esch. & Spreng. Syst. i, 790 (1825).

Not of frequent occurrence, but sometimes growing in the greatest profusion on the rocky beds of slow-flowing brooklets; Sybille Creek, July 8, 1894 (No. 309); Pole Creek, June 30, 1895 (No. 1337).

Lewisia rediviva, Pursh, Fl. ii, 368 (1814).

Comparatively rare, but occurring occasionally in profusion among the sage brush on the plains, and sometimes in the pine needles of rather open woods in the foothills. Sweetwater River, June 22, 1891, D. McLaren; Garfield Peak, July 29, 1894 (No. 679); Cummins, July 27, 1895 (No. 1545).

HYPERICACEÆ.

Hypericum Scouleri, Hook. Fl. Bor. Am. i, 111 (1830). *H. formosum Scouleri*, (Hook.) Coult.

Quite rare; in thickets along streams. Sybille Creek, July 8, 1894 (No. 341).

MALVACEÆ.

Sidalcea candida, Gray, Pl. Fendl. 20 and 24.

Frequent and abundant in thickets along streams in the mountains at 8,000-9,000 ft. Centennial Valley, September 8, 1891, B. C. Buffum; Cummins, July 31, 1895 (No. 1489).

Sidalcea malvæflora, Gray, Pl. Wright. i, 16 (1852).

Habitat and localities similar to those of the preceding; possibly of more frequent occurrence, the two species sometimes growing together. Saratoga, July 2, 1893, J. D. Parker; Cummins, July 28, 1895 (No. 1463).

Malvastrum coccineum, Gray, Mem. Am. Acad. iv, 21 (1848).

A common weed on the plains, in fields and fence corners. University Campus, June 22, 1894 (No. 280).

Sphæralcea acerifolia, Nutt. T. & G. Fl. N. A. i, 228 (1838).

Not abundant but widely distributed; in open woods at 8,000-9,000 ft. Union Pass, August 10, 1894 (No. 873); Centennial Valley, August 17, 1895 (No. 1727).

Sphæralcea Munroana, Spach. Proc. Am. Acad. xxii, 292 (1887).

Laramie, September 1, 1893; Sheridan Experiment Farm, September 1895.

LINACEÆ.**Linum Kingii**, Watson, King Rep. v, 49 (1871).

A few specimens of this species were secured by Prof Buffum in 1892, but without data; probably collected late in June, near Elk Mountain.

Linum perenne, L. Sp. Pl. 277 (1753). *L. Lewisii*, Pursh.

Remarkably abundant and luxuriant throughout the state. Found on dry, rocky ridges as well as on rich hillsides and valleys. The valley of Bacon Creek in August presents the appearance of a flax field. Laramie, June 12, 1894 (No. 241); Union Pass and Bacon Creek, August 1894 (No. 866).

Linum rigidum, Pursh, Fl. Am. Sept. 210 (1814).

Common in the eastern part of the state. Inyan Kara Divide, August 29, 1892, B. C. Buffum; Wheatland, July 9, 1894 (No. 384).

GERANIACEÆ.**Geranium cæspitosum**, James, Long's Exped. ii, 3.

Very frequent in the Laramie Hills, growing in scattered clumps on rocky ridges. By B. C. Buffum in 1892; Telephone Canon, June 15, 1894 (No. 233).

Geranium Fremonti, Torr. Gray, Pl. Fendl. 26.

Rare, observed but once; Union Pass, August 11, 1894 (No. 824).

Geranium Richardsoni, Fisch. Mey. Ind. Sem. Petr. iv, 37.

Frequent in the south-eastern part of the state at least; along streams and in damp thickets. Pole Creek, June 2, 1894 (No. 132); near Table Mountain, July 1, 1895 (No. 1403).

Oxalis stricta, L. Sp. Pl. 281 (1753).

This is the only species so far found in the state and this but once. Whalen Canon, July 18, 1894 (No. 522).

OELASTRACEÆ.

Pachystima Myrsinites, Raf. Am. Month. Mag. 176 (1819).

Occurring on the sides of wooded mountains. Tetons, August 22, 1894 (No. 977), at 7,500 ft.

RHAMNACEÆ.

Ceanothus Fendleri, Gray Pl. Fendl. 29 (1849).

Very rare, a single clump of it in an open valley, Laramie Peak, August 8, 1895 (No. 1637.)

Ceanothus velutinus, Dougl. Hook. Fl. Bor. Am. i, 125 (1830).

Presumably throughout the state; dry canon-sides; Beaver Creek by B. C. Buffum, July 17, 1892; Tetons, August 21, 1894 (No. 948); Cummins, July 31, 1895 (No. 1542).

VITACEÆ.

Vitis riparia, Michx. Fl. ii, 231. *Wild Grape*.

This was collected in fruit not yet ripe, in one locality only; on the banks of the Platte River, Fairbanks, July 14, 1894 (No. 468).

Ampelopsis quinquefolia, Michx. Fl. Bor. Am. i, 160 (1803) *Parthenocissus quinquefolia*, (L.) Planch.

Quite rare in the state, possibly not found in the more elevated districts at all. Hartville, July 16, 1894 (No. 554).

SAPINDACEÆ.

Acer glabrum, Torr. Ann. Lyc. N. Y. ii, 172 (1826).

A common shrub on rocky hillsides and in the canons. Telephone Canon, May 23, 1894 (No. 57); Laramie Hills May 25, 1895 (No. 1236). *Maple*.

Negundo aceroides, Moench. Meth. 334 (1794). *Acer Negundo*, L.

Occurring occasionally along streams. Introduced at Laramie for shade and decorative purposes. June 1, 1894 (No. 183); Big Muddy Creek, July 26, 1894 (No. 611). *Box Elder*.

ANACARDIACEÆ.

Rhus toxicodendron, L. Sp. Pl. (1753). *Rhus radicans*, L.

Ours is the low erect form. Among rocks in canons at 5,000-6,000 ft. Table Mountain, June 2, 1894 (No. 154); Hartville, July

16, 1894 (No. 557); noted also at Laramie Peak, growing in profusion in a rocky canon. *Poison Ivy*.

Rhus trilobata, Nutt. T. & G. Fl. i, 219 (1838).

A low, spreading shrub, frequently almost covering both sides and summits of the low rounded hills in the Laramie range. Table Mountain, June 2, 1894 (No. 159); Blue Grass Hills, July 8, 1894 (No. 322); Laramie Peak, August 7, 1895 (No. 1477).

LEGUMINOSÆ.

Thermopsis montana, Nutt. T. & G. Fl. i, 388 (1838).

Not common, occurring on sandy creek banks. Laramie River, fl. June 15, fr. August 19, 1891, B. C. Buffum.

Thermopsis rhombifolia, Richards. App. Frank. Journ. 13 (1823).

Abundant in sandy ravines and valleys in the hills, the great patches of yellow standing out in sharp contrast to the green grass and white rocks. Table Mountain, June 2, 1894 (No. 122); Laramie Hills, June 5, 1895 (No. 1240).

Lupinus argenteus, Pursh, Fl. 468 (1814).

A widely distributed and common species of this well represented and beautiful genus. Apparently at higher altitudes than the var. following. Chugwater Creek, July 7, 1894 (No. 301); Meadow Creek, August 9, 1894 (No. 972); Laramie Peak, August 7, 1895 (No. 1584).

Lupinus argenteus decumbens, Wats. Proc. Am. Acad. xviii, 532 (1873).

On creek banks in the hills and plains. Pole Creek, June 2, 1894 (No. 104).

Lupinus aridus, Dougl. Lindl. Bot. Reg. xv, 1242 (1829).

On the plains of the Sweetwater River, by Geo. M. Cordiner, September 6, 1894 (No. 1206).

Lupinus cæspitosus, Nutt. T. & G. Fl. i, 379.

A delicate little plant almost alpine in its habitat; observed but once; Union Peak, August 13, 1894 (No. 996).

Lupinus laxiflorus, Dougl. Lindl. Bot. Reg. xiv, 1140 (1828).

Frequent and sometimes covering great stretches of the sandy plain with its characteristic color. Blue Grass Creek, July 8, 1894 (No. 360); Lusk, July 21, 1894 (No. 584); also west slope of Wind River Mountains, August 14, 1894.

Lupinus leucophyllus, Dougl. Lindl. Bot. Reg. xiii, 1124 (1828).

Our earliest Lupine, found in great profusion on moist hillsides among the sage brush and even in shaded localities. Laramie Hills, June 2, 1894 (No. 151).

Lupinus ornatus, Dougl. Lindl. Bot. Reg. xv, 1216 (1829).

Certainly deserving its name; abundant in the locality noted; Gros Ventre River, August 16, 1894 (No. 1098).

Lupinus parviflorus, Nutt. Hook. & Arn. Bot. Beechy, 336.

Common along streams; Sybille Creek, August 8, 1894 (No. 315); Table Mountain, July 1, 1895 (No. 1414).

Lupinus Plattensis, Wats. Proc. Am. Acad. xvii, 124 (1890).

This rare and beautiful plant was observed in two localities only. Mexican Mines, July 20, 1894 (No. 589); Pole Creek, near Table Mountain, July 1, 1895 (No. 1401).

Lupinus pusillus, Pursh, Fl. Am. Sept. 468 (1814).

Found only on the sand ridges and dunes occurring occasionally on the plains of eastern Wyoming. Platte River, July 14, 1894 (No. 490); noted also south of Lusk.

Lupinus Sitgreavesii, Wats. Proc. Am. Acad. xiii, 527.

Occurs only at comparatively high altitudes in wooded mountains. Union Pass, August 12, 1894 (No. 896); frequent at 9,000 ft. and upward.

Medicago sativa, L. Sp. Pl. 778 (1753). *Lucerne, Alfalfa*; largely grown as a forage plant in the west; escaped from cultivation. Laramie, September 9, 1894 (No. 1136).

Melilotus alba, Lam. Encycl. iv, 63 (1797). *Sweet Clover*.

Persisting in fallow or abandoned fields. Laramie, October 2, 1894 (No. 1154.)

Melilotus officinalis, (L.) Lam. Fl. France, ii, 594 (1778).

Introduced and then persisting in abandoned areas for a number of years, possibly indefinitely. Laramie, June 23, 1895 (No. 1422).

Psoralea argophylla, Pursh, Fl. Am. Sept. 475 (1814).

Noted a number of times in eastern Wyoming; Platte River, July 14, 1894 (No. 497); from Inyan Kara Divide by B. C. Buffum, 1892, and from Sheridan by J. F. Lewis, 1895.

Psoralea lanceolata, Pursh, l. c.

Frequent on the dry foothills along the Platte River. Fairbanks, July 12, 1894 (No. 430); Orin Junction, August 14, 1892, B. C. Buffum.

Psoralea tenuiflora, Pursh, l. c.

Our commonest *Psoralea*, very abundant along the Platte and its tributaries. Laramie River, July 10, 1894 (No. 368); Blue Grass Creek, July 8, 1894 (No. 306).

Trifolium dasyphyllum, T. & G. Fl. N. A. i, 315.

This fine caespitose species almost clothes some of the otherwise naked rocky ledges in the Laramie foothills. Some specimens secured at Laramie Peak are quite erect with longer and less pubescent leaves. Laramie, May 25, 1894 (No. 68); June 5, 1895 (No. 1243).

Trifolium gymnocarpon, Nutt. T. & G. Fl. i, 320.

A rare and inconspicuous little plant, blossoming in late spring and shortly disappearing. Laramie, June 9, 1894 (No. 216); Experiment Farm, May 23, 1895 (No. 1230).

Trifolium longipes, Nutt. T. & G. Fl. i, 314 and 691.

Frequent in the mountains at 8,000-9,000 ft. Specimens from Saratoga and Bald Mountain; also Union Pass, August 13, 1895 (No. 1025).

Trifolium longipes reflexum, n. var.

This has the general habit of *T. longipes* but the flowers are at length quite reflexed; calyx lobes shorter and less villous. On the banks of Wind River at the foot of Union Pass, August 9, 1894 (No. 918).

Trifolium Parryi, Gray, Am. Journ. Sci. ii, 33.

Rare, in open spruce woods, Medicine Bow Mountains, August 21, 1895 (No. 1764).

Trifolium pratense, L. Sp. Pl. 768 (1753). *Red Clover*.**Trifolium repens**, L. Sp. Pl. 767 (1753).

This and the preceding becoming naturalized along irrigation ditches, in the streets and elsewhere. Laramie, September 15, 1894. *White Clover*.

Amorpha fruticosa, L. Sp. Pl. 713 (1753).

Frequent on the banks of the Platte in the eastern part of the state. Fairbanks, July 13, 1894 (No. 438).

Dalea aurea, Nutt. Fras. Cat. (1813). *Parosela aurea*, (Nutt.) Britton.

Very rare; on the plains of the Platte; Fairbanks, July 11, 1894 (No. 390).

Petalostemon candidus, Michx. Fl. Bor. Am. ii, 49 (1803). *Kuhnistera candida*, (Willd.) Kuntze.

Occasional, on the dry hills and plains bordering on the Platte. Orin Junction, August 14, 1891, B. C. Buffum.

Petalostemon multiflorus, Nutt. Journ. Phil. Acad. vii, 92 (1834).

This seems to be a much-named plant and illustrates nicely the stability that our nomenclature is acquiring. The new Check List gives *Kuhnistera multiflora*, (Nutt.) Heller, and, if I understand Mr. Rydberg rightly, his new name, *Kuhnistera, candida multiflora*, (Nutt.), Contrib. Nat'l Herb. iii, 3. (1895), is also the same. From the specimens at hand I am inclined to think that Mr. Rydberg is right in reducing the form to a variety. On the other hand his variety *occidentalis* does not seem to differ in any important respect from his *multiflora*, judging by his descriptions. Some specimens at hand will fall nicely under either.

Very frequent in the Laramie Hills and the foothills bordering on the Platte. July 9, 1894 (No. 330); Inyan Kara Divide by B. C. Buffum.

Petalostemon violaceus, Michx. Fl. Bor. Am. ii, 50 (1803). *Kuhnistera purpurea*, (Vent.) MacM.

Habitat and localities much the same as for the preceding. Orin Junction, July 14, 1891, B. C. Buffum; Platte Hills, July 9, 1894 (No. 331).

Astragalus adsurgens, Pall. Astrag. 40, t, 31 (1800). *A. Laxmanni*, Jacq.

Remarkably abundant in the south-eastern part of the state, occupying dry, stony or gravelly ridges on the plains or in the foothills.

Wallace Creek, July 29, 1894 (No. 646); Cummins, July 30, 1895 (No. 1514); at Laramie at various times.

Astragalus alpinus, L. Sp. Pl. 760 (1753).

Probably frequent in the higher mountain valleys; Pole Creek, June 3, 1894 (No. 174); Union Pass, August 11, 1894 (No. 840). Unusually large specimens with leaves varying from elliptical to orbicordate were obtained on Union Peak, August 13, 1894 (No. 993).

Astragalus bisulcatus, Gray, Pac. R. Rep. xii, 42 (1860.)

A very common species on the plains and in the foothills; Laramie, June 19, 1894 (No. 266); Garfield Peak, July 29, 1895 (No. 682); other numbers are 1316 and 1435.

Astragalus Canadensis, L. Sp. Pl. 757 (1753). *A. Carolinianus*, L.

Possibly confined to the eastern part of the state.

Lusk, July 21, 1894 (No. 582); Laramie Peak, August 7, 1895 (No. 1597).

Astragalus caryocarpus, Ker. Bot. Reg. t, 176 (1816). *A. crassica-
pus*, Nutt.

Infrequent; on the Laramie plains and on the east slopes of the Laramie range. Pole Creek, June 2, 1894 (No. 162); Laramie, June 25, 1894 (No. 201).

Astragalus convularius, Greene.

I am unable to cite the publication of this; the name was communicated by Prof. Sheldon; probably rare; Union Pass, August 10, 1894 (Nos. 743 and 869).

Astragalus Drummondii, Dougl. Hook. Fl. Bor. Am. i, 153 (1833).

Frequent in the foothills throughout the state; Pole Creek, June 2, 1894 (No. 86); Upper Wind River, August 10, 1894 (No. 763).

Astragalus flexuosus, Dougl., in Don. Gen. Syst. Gard. and Bot. ii, 256 (1832).

On wet, fertile creek banks; Chugwater, July 7, 1894 (No. 422); Pole Creek, July 1, 1895 (No. 1352).

Astragalus frigidus Americanus, Watson, Index, i, 193.

Very rare; South Fork, Crazy Woman Creek, August 7, 1892, B. C. Buffum.

Astragalus giganteus, Sheld. Bull. Minn. Geol. and Nat. Hist. Surv. ix. 65 (894).

Infrequent; Bald Mountain, August 15, 1892; Green River, August 26, 1894 (No. 1047).

Astragalus hypoglottis, L. Mant. ii, 274 (1771).

Frequent and abundant in wet meadows and along streams in our whole range. Saratoga, July 6, 1891; Meadow Creek, August 9, 1894 (No. 815). Fine specimens with ohroleucus flowers were obtained at Meadow Creek, August 9, 1894 (No. 775).

Astragalus Kentrophyta, Gray, Proc. Acad. Philad. 60 (1863).

Probably belonging to the Pacific slopes alone; on the banks of the Gros Ventre River, August 16, 1894 (No. 1077).

Astragalus juncens, Gray, Proc. Am. Acad. vi, 230.

Infrequent; on steep, dry stony hillsides; Saratoga, June 23, 1893; Gros Ventre River, August 17, 1894 (No. 1086).

Astragalus lonchocarpus, Torr. Pac. R. Rep. iv, 80.

What appears to be of this species was collected on Snake River, May 29, 1892, by Fred McCoullough.

Astragalus Missouriensis, Nutt. Gen. ii, 99 (1818).

Abundant on the Laramie plains but in the foothills giving place to *A. Shortianus*. Laramie, May 22, 1894 (No. 52); also in 1895 (No. 1227).

Astragalus Mortoni, Nutt. Journ. Acad. Phila. vii, 19 (1834).

On the Pacific slope only, infrequent; Gros Ventre River, August 16, 1894 (No. 1080).

Astragalus oroboides Americanus, Gray, Proc. Am. Acad. vi, 205 (1864). *A. oroboides*, Hornem.

Infrequent; Bacon Creek, August 15, 1894 (No. 917).

Astragalus pectinatus, Dougl. in Don. Gen. Syst. Gard. and Bot. ii, 257 (1832).

Frequent and abundant on the Laramie Plains; June 12, 1894 (No. 217).

Some forms of it seem to approach *A. Grayi* so closely as to make it difficult to know where to place them, such as my number 1304 from Centennial Valley, June 9, 1895.

Astragalus Purshii, Dougl. Hook. Fl. Bor. Am. i, 152 (1834).

Of frequent occurrence, but the plants few and scattering.

On the Laramie Plains, May 23, 1894 (No. 53); May, 1895 (No. 1228).

Astragalus sericoleucus, Gray, Am. Jour. Sci. II, xxxiii, 410 (1862).

Frequent on the plains and in the foothills, where it clothes the otherwise naked ground as with a purple carpet.

Laramie, May 18, 1894 (No. 38).

Astragalus Shortianus, Nutt. T. & G. Fl. N. A. i, 331 (1838).

On gravelly, stony hillsides; frequent in the Laramie range.

Telephone Canon, May 23, 1894 (No. 54); Centennial Valley, June 9, 1895 (No. 1286).

Astragalus spatulatus, Sheld. Bull. Minn. Geol. & Nat. Hist. Surv. ix, 19 (1894).

Very abundant both on the plains and in the foothills.

Laramie Hills, May 16, 1894 (No. 31); Centennial Valley, June 9, 1895 (No. 1301); also a white flowered variety from the latter place.

Astragalus tenellus, Pursh, Fl. Am. Sept. 473 (1814).

Seemingly throughout the state, in dry, sandy soil.

Laramie, June 19, 1894 (No. 267); Dubois, August 9, 1894 (No. 751); Cummins, July 26, 1895 (No. 1432).

Astragalus. (For other numbers see appendix).

Oxytropis deflexa, D C. Prodr. ii, 280.

Infrequent, in mountain Meadows, at 7,000-8,000 ft.; Union Pass, August 11, 1894 (No. 825); Laramie Peak, August 8, 1895 (No. 1530).

Oxytropis Lamberti, Pursh, Fl. Am. Sept. 740 (1814). *Spiesia Lamberti*. (Pursh) Kuntze.

The typical form is not frequent. As far as my observation goes, it is confined to the eastern part of the state. By the typical form is meant the purple-flowered form described in our manuals under this name. Table Mountain, July 1, 1895 (No. 1320).

Oxytropis Lamberti sericea, Nutt. T. & G. i, 339 (1838). *Spiesia Lamberti sericea*, (Nutt.) Rydberg.

Very rare; Laramie, 1893. Flowers violet.

Oxytropis (Spiesia) Lamberti ochroleuca, n. var.

Stout, grayish, with a close pubescence throughout; very many short stems from the large perennial root, each of which bears one to several long scape-like peduncles; flowers yellowish-white with sometimes a purple spot on the keel petals.

This is the frequently mentioned ochroleucus flowered form of this species, but it certainly, with us at least, forms a good and constant variety, if not species. It can always be distinguished by its stouter habit throughout, by the densely lanate scale-like stipules, by the shorter but thicker spike as well as by the very numerous and crowded stems and scapes. Exceedingly abundant; Pole Creek, June 2, 1894 (No. 119); Laramie, June 9, 1895 (No. 1302).
Loco.

Oxytropis monticola, Gray, Proc. Am. Acad. xx, 6.

Frequent in the vicinity of Laramie; May 23, 1894 (No. 60); June 9, 1895 (No. 1294).

Oxytropis multiceps, Nutt. T. & G. Fl. i, 341 (1838). *Spiesia multiceps*, (Nutt.) Kuntze.

Very rare; on a hilltop of disintegrated granite, near Horse Creek, June 9, 1894 (No. 214).

Oxytropis splendens, Dougl. Hook. Fl. Bor. Am. i, 147 (1833). *Spiesia splendens*, (Dougl.) Kuntze.

This truly splendid species is not rare in the grassy valleys at about 7,000-8,000 ft. and sometimes at lower altitudes. Table Mountain, July 2, 1895 (No. 1391); Cummins July 29, 1895.

Oxytropis sp. ? (Nos 669 and 928, see appendix).

Glyceria lepidota, Pursh, Fl. Am. Sept. 480 (1814).

Frequent near the Platte on the banks of small ditches and ravines. Willow Creek, July 22, 1894 (No. 627); Cheyenne, August 29, 1893.

Hedysarum boreale, Nutt. Gen. ii, 110 (1818). *H. Americanum*, (Michx.) Britton.

Probably infrequent except northward; Union Pass, August 10, 1894 (No. 877).

Hedysarum Mackenzii, Richards, App. Frank. Journ. 17 (1823). *H. Americanum Mackenzii*, (Richards.) Britton.

Throughout the state; Crazy Woman Creek, August 7, 1892; Dubois, August 9, 1894 (No. 752); Snake River, August 19, 1894 (No. 1087).

Vicia Americana, Muhl. Willd. Sp. Pl. ii, 1096 (1803).

Of frequent occurrence in thickets on stream banks. Cummins, July 29, 1895, two forms of it, (Nos. 1450 and 1478).

Vicia Americana truncata, Brewer, Bot. Cal. i, 158 (1876).

More frequent than the species; Wheatland, August 1892, B. C. Buffum; Table Mountain, June 30, 1895 (No. 1404).

Vicia linearis, (Nutt.) Greene, Fl. Fran. 3 (1891).

Especially abundant; on sandy plains and creek valleys everywhere.

Pole Creek, June 2, 1894 (No. 92); Laramie, June 1, 1894 (No. 172); Meadow Creek, August 9, 1894 (No. 776).

Vicia cracca, L. Sp. Pl. 735 (1753).

A chance introduction on the Laramie Experiment Farm, September 1895.

Lathyrus ornatus, Nutt. T. & G. Fl. N. A. i, 277 (1838).

Members of this genus are either very rare or the right localities have not yet been visited. A specimen in the herbarium from Cheyenne, by Miss Helen Furniss, June 1892.

ROSACEÆ.**Prunus Americana**, Marsh, Arb. Am. 111 (1785).

Rare in the southeastern part of the state and probably infrequent everywhere except in the lower altitudes of the northeastern part, where it is reported very plentiful.

Fairbanks, July 18, 1894 (No. 572). *Wild Plum*.

Prunus demissa, Walp. Rep. ii, 10 (1843).

This and the succeeding species have so much in common that it is difficult to separate them. It may be that none of the specimens are *P. Virginiana*, but rather only forms of *P. demissa*. Common on dry creek banks in the hills.

Telephone Canon, June 15, 1894 (No. 230); Table Mountain, June 30, 1895 (No. 1402). *Wild Cherry*, *Choke Cherry*.

Prunus Virginiana, L. Sp. Pl. 473 (1753).

Teton Mountains, August 21, 1894 (No. 943), and by B. C. Bufum, 1892.

Spiraea arbuscula, Greene, Erythea, iii, 63 (1895).

Infrequent and, I think, found only at high elevations, 8,000 ft. and upward.

Teton Mountains, August 21, 1894 (No. 941).

Spiraea discolor dumosa, Watson, Pursh Fl. 342 (1814).

A handsome shrub, common on rocky ledges at 8,000 ft. and upward.

Casper Mountain, July 26, 1894 (No. 607); Garfield Peak, July 29, 1894 (No. 657); also observed at Laramie Peak and in the Medicine Bow Mountains in 1895.

Spiraea lucida, Dougl.

Very rare in the state.

Teton Mountains, August 21, 1894 (No. 949).

Physocarpus Torreyi, Maxim. *Neillia Torreyi*, Watson, Proc. Am. Acad. xi, 136.

Common in the hills and mountains.

Table Mountain, June 2, 1894 (No. 116); Platte River, July 14, 1894 (No. 490).

Rubus Nutkanns, Mocino, Lindl. Bot. Reg. t. 1368 (1830).

Not common in the parts of the state collected.

Teton Mountains, August 21, 1894, and Centennial Hills, August 18, 1895 (No. 1676). *Thimble-berry*.

Rubus strigosus, Michx. Fl. i, 297 (1803).

The *Red Raspberry*, growing in the greatest profusion on rocky and partially wooded hillsides, especially on ground once burned over. Immensely productive.

Union Peak, August 13, 1894 (No. 997). Cummins, July 31 1895 (No. 1476).

Purshia tridentata, D C. Trans. Linn. Soc. 12, 157.

A scragly prostrate shrub, common on low hilltops and hillsides.

Pole Creek, June 2, 1894 (No. 82); Wallace Creek, July 29, 1894 (No. 676); Centennial Valley, June 9, 1895 (No. 1270).

Cercocarpus parvifolius, H. & A. Bot. Beechey, 337 (1841).

This may be called the most characteristic shrub of stony foothills.

Laramie Hills, June 15, 1894 (No. 237); Platte Hills, July 14, 1894 (No. 462). *Mountain Mahogany*.

Geum macrophyllum, Willd. Enum. i, 557 (1809).

Mr. Rydberg* suggests the probability that this and the following are varieties of the same species. The specimens before me, however, seem perfectly distinct. Near streams.

Bacon Creek, August 15, 1894 (No. 920); Cummins, July 30, 1895 (No. 1576).

Geum strictum, Ait. Hort. Kew. ii, 217 (1789).

Same habitat as the preceding.

Sybilie Creek, July 8, 1894 (No. 407); Cummins, July 30, 1895 (No. 1517).

Geum triflorum, Pursh, Fl. 736 (1814).

This fine species is common in wet valleys at 7,000-9,000 ft. Our manuals fail to note that the style is jointed in the middle in young

*Contrib. Natl. Herb. iii, 3, 157 (1895).

specimens, but as the apical portion is early deciduous it appears perfectly straight in maturer blossoms.

Union Pass, August 11, 1894 (No. 829); Saw Mill Creek, May 25, 1895 (No. 1258).

Fragaria vesca Americana, Porter, Bull. Torr. Bot. Club, xvii, 15. (1890).

In mountain meadows and valleys, in parks and on wet hillsides everywhere. ' Sometimes fruiting abundantly, the berries small but sweet.

Horse Creek, June 9, 1894 (No. 207). *Strawberry*.

Fragaria Virginiana Illinoensis, Prince, Gray Man Ed. 5, 155 (1867).

This species is rare, at least about Laramie, but specimens collected by A. H. Danielson near Jelm Mountain, May, 1895, seem to be of this form (No. 1209).

Potentilla anserina, L. Sp. Pl. 495 (1753).

Common in wet soils, especially near slightly alkali marshes. Laramie all summer.

Collected on Green River, August 26, 1894 (No. 1039).

Potentilla arguta, Pursh, Fl. Am. Sept. 736 (1814).

Forming immense yellow patches among the rocks in the hills. A fine plant.

Pole Creek Hills, June 2, 1894 (No. 95); June 30, 1895 (No. 1351).

Potentilla dissecta, Pursh, Fl. Am. Sept. (1814).

This fine species is probably confined to high elevations.

Teton Mountains, August 22, 1894 (No. 970); LaPlata Mines, August 20, 1895 (No. 1773).

Potentilla fruticosa, L. Sp. Pl. 495 (1753).

Common on the banks of mountain streams.

Wind River, August 9, 1894 (No. 748); Little Sandy, August 30, 1894 (No. 1127).

Potentilla glandulosa, Lindl. Bot. Reg. xix, t. 1583 (1833).

Occasional along streams in sandy loam.

Union Pass, August 12, 1894 (No. 867); Cummins, July 30, 1895 (No. 1493).

Potentilla gracilis, Dougl. Hook. Bot. Mag. (1830).

This is a most polymorphous species, the forms of it differing strikingly as to tomentum, hirsuteness, leaf margin, etc. It seems

probable that a careful examination will show at least some varieties which ought to be separated from the species. In wet meadows and along mountain streams.

Laramie River, July 9, 1894 (No. 325); Wallace Creek, July 29, 1894 (No. 665); Wind River Mountains, August 13, 1894 (No. 931); Table Mountain, June 30, 1895 (No. 1347); La Plata Mines, August 21, 1895 (No. 1821).

Potentilla gracilis fastigiata, Watson, Proc. Am. Acad. viii, 557 (1873).

Union Pass, August 13, 1894 (No. 990); Centennial Valley, August 25, 1895 (No. 1858).

Potentilla gracilis flabelliformis, Torr. & Gray, Fl. (1838).

A rare and beautiful plant, the deeply pinnatifid leaflets densely white tomentose on the lower surface.

Meadow Creek, August 9, 1894 (No. 786).

Potentilla Hippiana, Lehm. Nov. Stirp. Pug. ii, 197 (1830).

Very common on rocky slopes and hills.

Laramie Hills, July 7, 1894 (No. 410); Garfield Peak, July 29, (No. 651); Table Mountain, June 29, 1895 (No. 1368).

Potentilla Hippiana pulcherrima, Watson, Proc. Am. Acad. viii, 555 (1873). *Potentilla pulcherrima*, Lehm.

This is not common, and seems to have affinities with *P. gracilis*, *P. Pennsylvanica* and *P. Hippiana*.

La Plata Mines, August 22, 1895 (No. 1789).

Potentilla humifusa, Nutt. Gen. i, 330 (1818).

Common early in the year on gravelly hillsides.

Laramie Hills, June 2, 1894 (No. 99); May 18, 1895 (No. 1216).

Potentilla Norvegica, L. Sp. Pl. 499 (1753). *P. Monspeliensis*, L.

Apparently throughout the state.

Platte River and Willow Creek, July 1894 (Nos. 502 and 565); Laramie, September 16, 1894 (No. 1143); Cummins, July 30, 1895 (No. 1474).

Potentilla Pennsylvanica, L. Mant. 76 (1767).

Observed but once.

Bessemer, on the Platte River, July 26, 1894 (No. 612).

Potentilla Pennsylvanica strigosa, Pursh, Fl. Am. Sept. 356 (1814).

In rather dry valleys; more frequent than the species.

Whalen Canon, July 18, 1894 (No. 525); Cummins, July 30, 1895 (No. 1545).

Potentilla Plattensis, T. & G. Fl. i, 439 (1838).

On sandy flats bordering on streams.

Horse Creek, June 9, 1894 (No. 206); Laramie River, June 19, 1894 (No. 265).

Potentilla pinnatisecta, n. sp.

This form should not have been suppressed. In Watson's King's Report it appears as *P. diversifolia pinnatisecta*. The points upon which he based the variety are well taken but not strongly enough emphasized. The following, it seems to me, justify the separation of this form from *P. Plattensis* as a distinct species. *P. Plattensis* has been repeatedly observed but only on bottom lands near streams and, I think, thus far, with one exception,* only on streams tributary to the Platte. *P. pinnatisecta* is strictly alpine. The specimens before me were collected on the naked summits of the Medicine Bow Mountains, above timber line at about 11,500 feet, growing among the rocks in the most bleak and barren places.

The two differ markedly in habit as well as in habitat. *P. Plattensis* is decumbent at base, with branches diffuse or loosely spreading. *P. pinnatisecta*, while its branches are slightly decumbent at base, yet the plant as a whole may be spoken of as strictly erect. The cymes are more regular and more open. The leaves are longer, leaflets less crowded and inclined to be pedately parted rather than pinately, strictly cuneate at base. Leaves largely radical, those on the stem greatly reduced. Petioles and stems nearly glabrous with a brownish glaucous hue. Leaves glabrous on the upper surface, softly silky villous on the lower. The plant 5-8 inches high.

Potentilla supina, Michx. Fl. Bor. Am. i, 304 (1803). *P. paradoxa*. Nutt.

Not of frequent occurrence; Hartville, July 16, 1894 (No. 555); Cummins, July 28, 1895 (No. 1525).

Sibbaldia procumbens, L. Sp. Pl. 284 (1753).

Frequent at high altitudes, 10,000 ft. and upward. Union Peak. August 13, 1894 (No. 1010); La Plata Mines, August 23, 1895 (No. 1799).

*Bot. Death Valley Exped. Contrib. Natl. Herb. iv, 112 (1893).

Chamaerhodos erecta, Bunge. Ledeb. Fl. Alt. i, 431.

Observed but once but then in the greatest abundance, on a sand-bar of the Laramie River, June 18, 1894 (No. 261).

Agrimonia Eupatoria, L. Walt. Fl. Car. 131 (1788). *A. Striata*, Michx.

Not at all common; Laramie Peak, on a wooded stream, August 9, 1895 (No. 1653).

Rosa acicularis, Lindl. Ros. Monog. 44, t. 8 (1820).

Found most frequently at the foot of dry, clayey creek banks.

Pole Creek, June 2, 1894 (No. 134); Centennial Valley, August 18, 1895 (No. 1697).

Rosa Arkansana, Porter, Syn. Fl. Col. 38 (1874).

A fine species often met with in wet ravines in the mountains.

Mexican Mines, July 20, 1894 (No. 567); Table Mountain, June 30, 1895 (No. 1336).

Rosa blanda, Ait. Hort. Kew. ii, 202 (1779).

Rather common in canons and the adjacent hillsides.

Whalen Canon, July 18, 1894 (No. 520); Table Mountain, June 30, 1895 (No. 1343).

Rosa Fendleri, Crepin, Prim. Monog. Ros. 452 (1874).

Probably quite rare in the state,

Boulder Creek, August 27, 1894 (No. 1101).

Rosa Sayi, Schwein. Keating, Long's Exped. Appx. 113.

I note that recently this has been made a synonym for *R. acicularis*, but in Watson's Rev. Ros. N. A. 340 (1885), the two forms are kept distinct. If the two forms before me are correctly determined he is amply justified in doing so.

Table Mountain, June 30, 1895 (No. 1643). Also by B. C. Buffum, June 6, 1892.

Rosa Woodsii, Lindl. Ros. Monog. 21 (1820).

A small form, common, in the dry hills and sandy ravines, inclined to be prostrate.

Laramie Hills, June 12, 1894 (No. 242).

Pyrus sambucifolia, Cham. & Schlecht. Linnæa, ii, (1827). *Sorbus sambucifolia*, Roem.

Rather rare; Teton Mountains, August 22, 1894 (No. 982); also from the Centennial Valley, by B. C. Buffum.

Oratægus Douglasii, Lindl. Bot. Reg. 21, t, (1810).

Very scarce, only a few specimens observed in one locality. These are not typical, yet can hardly belong to the following species though approaching it more closely than any other.

Casper, July 25, 1894 (No. 606). *Hawthorn*.

Oratægus rivularis, Nutt. T. & G. Fl. i, 464 (1840).

Of rather frequent occurrence on some streams.

Gros Ventre River August 22, 1894 (No. 1066).

Amelanchier alnifolia, Nutt. Journ. Acad. Phila. viii, 22 (1834).

Very common in the foothills and along streams.

Telephone Canon, June 2, 1894 (No. 117).

Amelanchier pumila, Nutt. Roem. Syn. Monog. iii, 145.

Prof. E. L. Greene, of Catholic University, Washington, D. C., writes me that in 1893 I sent him some material as *A. alnifolia*, which, on examination, proves to be the long suppressed *A. pumila* of which he writes as follows: "It may be recognized by its being perfectly glabrous; by having much longer and narrower petals and by having its leaves serrate almost from base to apex, whereas *A. alnifolia* has its leaves serrate only from the middle upwards."

On examination of the material in our herbarium I find that our 1893 material answers to this description of *A. pumila* perfectly.

Laramie Hills, May 1893. *Service Berry*.

SAXIFRAGAACEÆ.**Saxifraga bronchialis**, L. Sp. Pl. i, 400 (1753).

Teton Mountains, at high elevations, August 21, 1894 (No. 976).

Saxifraga Jamesii, Torr. Ann. Lyc. N. Y. ii, 204.

This rare species was observed but once. Jackson's Hole, August 22, 1894 (No. 971).

Saxifraga integrifolia, Hook. Fl. Bor. Am. i, 249 (1834).

Grassy places in the mountains, but not at all common.

Bald Mountain, August 16, 1892, B. C. Buffum; Union Pass, August 10, 1894 (No. 930).

Saxifraga nivalis, L. Sp. Pl. i, 401 (1753).

This species is not strictly alpine if this idea be represented solely by altitude. Common, and blossoming in May at 7,000 ft., and successively throughout the season at higher and higher altitudes.

Wind River Mountains, July 20, 1892, B. C. Buffum; Pole Creek, June 2, 1894 (No. 127); La Plata Mines, August 22, 1895.

***Saxifraga punctata*, L. Sp. Pl. 401 (1753).**

Frequent in wet, shaded ravines at high elevations.

Union Pass, August 12, 1894 (No. 843), also from Bald Mountain, by B. C. Buffum.

***Saxifraga Virginienensis*, Michx. Fl. Bor. Am. i, 269 (1803).**

This is less common than *S. nivalis* which it closely resembles.

In the lower valleys of the state. Bald Mountain, August 15, 1892, by B. C. Buffum.

***Tellima tenella*, Walp. Rept. ii, 371 (1843).**

Rare, on the sandy slopes of valleys.

Horse Creek, June 11, 1892; Bald Mountain, August 15, 1892, B. C. Buffum.

***Mitella pentandra*, Hook. Bot. Mag. lvi, t. 2933 (1829).**

Frequent in damp ravines in the mountains.

Teton Mountains, August 21, 1894 (No. 944); Laramie Peak, August 8, 1895 (No. 1623).

***Mitella trifida*, Graham. var. *integripetala*, Rose.**

This new variety is founded upon material collected by B. C. Buffum, and sent by myself to Dr. J. N. Rose, who named it and I suppose published it, but I am unable to cite the publication. It differs from the species mainly in its entire petals and its leaves, which are incisely dentate rather than crenate dentate. Certainly very rare.

Bald Mountain, August 15, 1892.

***Heuchera parviflora*, Nutt. T. & G. Fl. i, 581 (1838).**

Very common on stony ridges and hillsides in the Laramie range.

Pole Creek, June 2, 1894 (No. 163); Table Mountain, June 28, 1895 (No. 1344); also observed in the Medicine Bow Mountains, August 1895.

***Parnassia fimbriata*, Banks, in Koenig & Sims, Ann. Bot. i, 391 (1805).**

Along streams and in wet thickets at high altitudes.

Head of Green River, August 26, 1894 (No. 1034); La Plata Mines, August 22, 1895 (No. 1803).

Parnassia palustris, L. Sp. Pl. 273 (1753).

Quite rare and not readily distinguished from the next except by the cordate leaves.

Bald Mountain, August 16, 1892, B. C. Buffum.

Parnassia parviflora, D C. Prodr. i, 320.

Rather common on grassy stream banks almost in the water.

Fort Washakie, August 5, 1894 (No. 746).

Jamesia Americana, T. & G. Fl. i, 593 (1840).

A very handsome shrub when in blossom. Rare; in rocky canons.

From Saratoga by B. C. Buffum, June 1892; Table Mountain, July 1, 1895 (No. 1418).

Ribes aureum, Pursh, Fl. 164 (1814).

Common in the canons of the Platte, where the black fruited form seems to predominate. Introduced in Laramie as an ornamental shrub.

Fairbanks, July 18, 1894 (No. 571). *Missouri* or *Flowering Currant*.

Ribes aureum chrysococcus, Rydberg, Fl. Neb. xxi, 71 (1895).

Mr. Rydberg founds this variety upon the character of the fruit. It is what has been called the yellow fruited form of the preceding. Noted by Mr. Rydberg, it may again be stated that there is no discernible difference between the flowers and leaves of the two forms, but the fruits are strikingly different, and apparently the difference is constant. The variety is very common in the Platte canons at Fairbanks and produces large, finely flavored berries in abundance, which are gathered in large quantities for domestic use by the residents of the place.

Fairbanks, July 18, 1894 (No. 571a). *Yellow Currant*.

Ribes cereum, Dougl. Trans. Hort. Soc. Lond. vii, 512 (1830).

Exceedingly common on dry, rocky hillsides throughout the state. Laramie Hills, May 16, 1894 (No. 30); May, 1895 (No. 1231).

Ribes divaricatum, Dougl. Trans. Hort. Soc. Lond. vii, 515 (1830).

Presumably rare; Union Pass, Aug. 10, 1894 (No. 862).

Ribes divaricatum irrigum, Gray, Am. Naturalist, x, 273.

Growing in great profusion in the copses bordering stream banks and producing an abundance of very acid but pleasantly flavored fruit.

Pole Creek, June 2, 1894 (No. 96). Observed in many other parts of the state, but the borders of Wallace Creek may be spoken of as one immense *Gooseberry* patch.

Ribes floridum, L'Her. Stirp. i, 4 (Ehrh. Beitr. vi. 119).

Observed but once; Whalen Canon, July 18, 1894 (No. 541).

Ribes lacustre, Poir. Encycl. Suppl. ii, 856 (1811).

Very common in copses on canon streams.

Teton Mountains, August 21, 1894 (No. 938); Centennial Valley, fs. June 9, 1895 (No. 1556); fr. August 17, 1895 (No. 1689).

Ribes lacustre parvulum, Gray, Bot. Cal. i, 206 (1876).

Frequent in wet thickets at subalpine stations.

Union Peak, August 13, 1894 (No. 1022); LaPlata Mines, August 23, 1895 (No. 1801).

Ribes lacustre molle, (?) Gray, Bot. Cal. i, 206 (1876).

My specimens are clearly a variety of *R. lacustre*, but as I have no description of this variety I put it here tentatively. It has larger fruits and is more softly pubescent than the species.

Union Pass, August 13, 1894 (No. 1073).

Ribes leptanthum, Gray, Pl. Fendl. 53 (1849).

This horridly prickly form must be very rare in the state for, though it is naturally conspicuous, I have observed it but once.

Garfield Peak, July 29, 1894 (No. 695).

Ribes oxyacanthoides, L. Sp. Pl. 201 (1753).

Collected only in one locality, and probably confined to the eastern part of the state.

Pole Creek, June 2, 1894 (No. 129).

Ribes oxyacanthoides saxosum, (Hook.) Coville, Contrib. Natl. Herb. iv, 100 (1893).

This I at first thought the same as the preceding, but on comparing my specimens with description, l. c., I find that they must be referred to this variety.

Bacon Creek, August 25, 1894 (No. 1044).

Ribes sanguineum variegatum, Wats. Bot. King Surv. 100 (1871).

Union Pass, August 10, 1894 (No. 860).

CRASSULACEÆ.

Sedum Douglasii, Hook. Fl. Bor. Am. i, 228.

Rare; collected at Wheatland, June 11, 1891, B. C. Buffum.

Sedum rodanthum, Gray, Am. Journ. Sci. ii, 33. 405.

In wet bogs in the mountains; subalpine.

Union Pass, August 13, 1894 (No. 929); La Plata Mines, August 23, 1895 (No. 1703).

Sedum stenopetalum, Pursh Fl. i, 324 (1814).

Exceedingly abundant on rocky slopes in the foothills.

Laramie Hills, July 7, 1894 (No. 351); Table Mountain, June 29, 1895 (No. 1467).

HALORAGÆÆ.

Hippuris vulgaris, L. Sp. Pl. 4 (1753).

Not at all common; in a muddy bog in Lander, August 3, 1894 (No. 694).

Callitriche palustris, L. Sp. Pl. 969 (1753).

In shallow ponds and pools; rather frequent.

Near Green River, August 25, 1894 (No. 1102); Centennial Valley, August 25, 1895 (No. 1860).

Myriophyllum verticillatum, L. Sp. Pl. 992 (1753).

Green River, August 26, 1894 (No. 1038).

ONAGRACEÆ.

Epilobium adenocaulon, Hausskn. Oest. Bot. Zeitschr. xxix (1879).

Common about springs and wet places.

Laramie, August, 1891, B. C. Buffum; Whalen Canon, July 19, 1894 (No. 545); Lander Creek, August 31, 1894 (No. 1107).

Epilobium brevistylum, Barbey, Brewer & Wats. Bot. Cal. i, 220 (1876).

This specimen I had called *E. affine*, but a closer study of text and plate in Rev. Epilobium by Trelease leads me to believe that these specimens belong to the above.

Wind River Mountains, August 11, 1894 (No. 852).

Epilobium delicatum, Trelease, Mo. Bot. Garden Rep. ii, (1891).

Of the two specimens before me, the one seems nearly typical, the other is rather large flowered but too immature for close comparison.

Cummins, July 30, 1895 (No. 1466); Bald Mountain, August 15, 1892, B. C. Buffum.

Epilobium Hornemanni, Reichenb. Icon. Crit. ii, 73 (1824).

Again I have two specimens, one typical except that it is very dwarf; the other with leaves sessile instead of short petiolate. However, I am unable to refer them to any other species.

Bald Mountain, August 15, 1892; LaPlata Mines, August 23, 1895 (No. 1797).

Epilobium latifolium, L. Sp. Pl. i, 347 (1753). *Chamaenerion latifolium* (L.) Sweet.

A rare and handsome species. The specimens before me may possibly be var. *grandiflorum*, Britton.

On a steep clay bank of the Gros Ventre River, August 16, 1894 (No. 1081).

Epilobium paniculatum, Nutt. T. & G. Fl. i, 490 (1840).

Common on sandy soil among small undershrubs on stream banks.

Wallace Creek, July 28, 1894 (No. 643); Cummins, July 28, 1895 (No. 1456).

Epilobium spicatum, Lam. Fl. Fr. iii, 482 (1778). *Chamaenerion angustifolium*, (L.) Scop.

Common in the mountains, especially in districts recently burned over.

Garfield Peak, July 29, 1894 (No. 691). *Fire Weed*.

Epilobium suffruticosum, Nutt.

Large typical specimens were obtained on a dry, rocky creek bed. Warm Spring Creek, August 10, 1894 (No. 798).

Clarkia Pulchella, Pursh, Fl. i, 260, t. 11 (1814).

Probably rare; specimens received from Snake River, May 29, 1892, collected by Fred McCullough.

Gayophytum racemosum, T. & G. Fl. i, 514 (1840).

This and the following species grow in the greatest profusion in the hills, in similar habitats, viz., dry banks, hillsides and ravines.

Sybille Creek, July 8, 1894 (No. 310); Table Mountain, July 1, 1895 (No. 1371); observed in many other localities.

Gayophytum ramosissimum, T. & G. Fl. i, 513 (1840).

Saratoga, June 23, 1898; Sybille Creek, July 8, 1894 (No. 308).

Oenothera albicaulis, Nutt. Fraser's Cat. 1813. *Anogra pallida*, Britton.

Common on sandy ridges along the Laramie River.

Fisher's Ranch, June 19, 1894 (No. 264); Whalen Canon, July 17, 1894 (No. 511).

Oenothera biennis, L. Sp. Pl. 346 (1753). *Onagra biennis* (L.) Scop.

The specimens before me show considerable variation, but none of them seem to fall into any of the existing varieties.

Whalen Canon, July 18, 1894 (No. 519); Laramie Peak, August 8, 1895 (No. 1646).

Oenothera brachycarpa, Gray, Pl. Wright, i, 70.

On gravelly hillsides in the mountains; not frequent.

Centennial Valley, June 9, 1895 (No. 1274); Gros Ventre River, August 16, 1894 (No. 926).

Oenothera breviflora, T. & G. Fl. i, 506 (1840).

This was found in considerable abundance in one spot only, the naked soil of an old buffalo wallow.

Bacon Creek, August 25, 1894 (No. 1043).

Oenothera caespitosa, Nutt. Gen. i, 246 (1818).

Abundant on the naked red clay hills near Laramie; May 23, 1894 (No. 58); May 30, 1895 (No. 1221).

Oenothera coronopifolia, T. & G. Fl. N. A. i, 495 (1840). *Anogra coronopifolia*, (T. & G.) Britton.

Common on the Laramie Plains.

University Campus, June 1894 (No. 222); June 1895 (No. 1426).

Oenothera Hartwegi, Benth. Pl. Hartw. v, (1843).

On dry, gravelly clay hills; not common.

Blue Grass Creek, July 9, 1894 (No. 375).

Oenothera Hartwegi lavandulaefolia, Watson, Proc. Am. Acad. viii, 590 (1873).

These specimens are from type locality, viz., "Plains of the Platte." Seemingly quite rare.

Whalen Canon, July 18, 1894 (No. 526).

Oenothera pinnatifida, Nutt. Gen. i, 245 (1818). *Anogra albicaulis*, (Pursh) Britton.

Frequent on sandy river bottoms.

Wheatland, July 9, 1894 (No. 380); North Fork Wind River, August 9, 1894 (No. 779).

Oenothera serrulata, Nutt. Gen. i. 246 (1818). *Meriolix serrulata*, (Nutt.) Walp.

Infrequent; Orin Junction, August 14, 1891, B. C. Buffum;
Whalen Canon, July 18, 1894 (No. 524).

Oenothera trichocalyx, Nutt. T. & G. Fl. i, 494 (1840).

Particularly rare in the state; only a few specimens secured.
Bull Lake Creek, August 8, 1894 (No. 730).

Oenothera triloba, Nutt. Journ. Acad. Phil. ii, 118 (1821). *Lavauzia triloba*, (Nutt.) Spach.

Gaura coccinea, Nutt. Fraser's Cat. (1813).

A common weed everywhere.

Uva, July 10, 1894 (No. 367); Laramie, July 24, 1895 (No. 1430).

Gaura parviflora, Dougl. Hook. Fl. Bor. Am. i, 208 (1833).

Belonging to the lower altitudes of the state.

Two Bar Ranch, Blue Grass Creek, July 9, 1894 (No. 376).

LOASACEÆ.

Mentzelia albicaulis, Dougl. Hook. Fl. Bor. Am. i, 222 (1833).

In sandy thickets along streams or on hillsides.

Grant, on Sybille Creek, July 8, 1894 (No. 336); Cummins, July 28, 1895 (No. 1471).

Mentzelia chrysantha, Engelm.

This is probably rare, as only a few specimens were observed.
No citations are at hand; reported from Canon City, Colo., and southern Utah in Coulter's Manual.

Big Wind River, August 5, 1894 (No. 705).

Mentzelia dispersa, Watson, Proc. Am. Acad. xi, 115 and 137.

Common in dry ravines in the hills.

Table Mountain, June 30, 1895 (No. 1375); Cummins, July 28, 1895 (No. 1455).

Mentzelia lævicaulis, T. & G. Fl. N. A. i, 535 (1840).

In disintegrated eruptive rock, Garfield Peak, July 29, 1894 (No. 678).

Mentzelia Nelsonii, Greene, Erythea, iii, 70 (1895).

The following is the original description: "Annual, 2 or 3 feet high, freely and widely branching, the stoutish branches with a sparingly hispidulous whitish bark; lower leaves unknown, those of the branches from distinctly hastate-ovate to almost deltoid-ovate,

1 or 2 inches long, coarsely toothed or indistinctly lobed, both faces green and rather sparsely appressed-hispidulous, the hairs of the upper surface stouter and more enlarged at base; flowers many, small, orange-colored, sessile, or nearly so, in the forks and axils; ovary subcylindric, less than one-half inch long at flowering time and after; calyx-lobes slenderly subulate at flowering, almost as long as the ovary; petals 5 only, about 4 lines long; stamens few; filaments filiform; anthers suborbicular; capsule and seeds unknown. A very well marked species, certainly allied to the Mexican *M. aspera*, but much larger and more diffusely branching, the leaves relatively broader."

It is probably quite local; collected in a canon leading to the Platte River, July 13, 1894 (No. 439).

***Mentzelia nuda*, T. & G. Fl. N. A. i, 535 (1840).**

Frequent, and always in abundance; sandy plains and hillsides; somewhat variable as to habit.

Big Sandy, July 18, 1892; Grant, July 8, 1894 (No. 338); Cummins, July 29, 1895 (No. 1470).

***Mentzelia ornata*, T. & G. Fl. N. A. i, 534 (1840).**

Also common on sandy foothills near the Platte and its tributaries.

Fairbanks, July 14, 1894 (No. 486); Big Horn Mountains, August 5, 1892.

***Mentzelia pumila*, T. & G. l. c.**

On a stony, gravelly hillside, Cummins, July 29, 1895 (No. 1436).

CACTACEÆ.

It is not at all probable that the following numbers represent at all adequately our *Cactaceæ*, but the difficulty of preparing good specimens has caused them to be neglected.

***Cactus viviparus*, Nutt. in Fraser's Cat. (1813).**

This is exceedingly rare; only two plants thus far observed.

Ione Ranch, on Laramie River, August 10, 1895 (No. 1865).

***Echinocactus Simpsoni*, Engelm. Trans. St. Louis Acad. ii, 197 (1863).**

Frequent on the plains and in the valleys of the Laramie range. Laramie, June 15, 1894 (No. 75).

Cereus viridiflorus, Engelm. Pl. Fendl. 50 (1849).

Rare, seemingly confined to the east slopes of the Laramie range.
Pole Creek, June 2, 1894 (No. 113).

Opuntia fragilis (?) Haw. Suppl. Pl. Succ. 82 (1819).

A few specimens from Fairbanks, on the Platte, are thought to belong here. July 14, 1894 (No. 465).

Opuntia polyacantha platycarpa, (Engelm.) Coulter, Contrib. Natl. Herb. (III) vii, 436 (1896).

Probably several varieties of this species are found on our plains, but no specimens are at hand except of this. On the dry, gravelly plains the species, in some form, is immensely abundant, forming in places almost continuous beds.

Table Mountain, June 2, 1894 (No. 115).

UMBELLIFERÆ.

Sanicula Marylandica, L. Sp. Pl. 235 (1753).

Rare in the parts of the state collected, but probably frequent in the northeast.

Laramie Peak, August 8, 1895 (No. 1607).

Musenium tenuifolium, Nutt. T. & G. Fl. N. A. i, 642 (1840). *Adorium tenuifolium*, (Nutt.) Kuntze.

Usually reported as rare, but it is found in the greatest profusion in the Laramie range, on rocky ridges. June 7, 1894 (No. 176); Platte Hills, July 11, 1894 (No. 391).

Musenium trachyspermum, Nutt. l. c.

Common on the Laramie plains, appearing very early.

Laramie, May 7, 1894 (No. 10); observed outside of Laramie but not collected.

Bupleurum Americanum, C. & R.

Seemingly quite rare; a fine species.

Union Pass, August 14, 1894 (No. 893).

Bupleurum ranunculoides, L. Sp. Pl. 237 (1753).

Judging by place of collection, this may be denominated alpine.

Teton Peaks, August 21, 1894 (No. 972).

Harbouria trachypleura, C. & R.

Frequent in fertile mountain valleys at 7,000-8,000 ft.

Table Mountain, June 2, 1894 (No. 160); Saw Mill Creek, May 25, 1895 (No. 1238).

***Oicuta maculata*, L. Sp. Pl. 256 (1753).**

In wet places along streams, particularly in the lower altitudes.

Lusk, July 21, 1894 (No. 573); Meadow Creek, August 9, 1894 (No. 790); Laramie River, near Ione Ranch, August 10, 1895 (No. 1557).

***Carum Gairdneri*, B. & H. Gen. Pl. i, 891.**

In fertile valleys in the mountains, particularly such as are partially covered with undershrubs. The "Yamp" of the Indians.

Garfield Peak, July 29, 1894 (No. 660); Gros Ventre River, August 18, 1894 (No. 1096).

***Zizia cordata*, DC. Prodr. iv, 100 (1830).**

Along streams and on moist hillsides even to their summits.

Horse Creek, June 9, 1894 (No. 204); Pole Creek, June 29, 1895 (No. 1327).

***Sium cicutæfolium*, Gmelin. Syst. ii, 482 (1791).**

In the margins of fresh water lakes and ponds.

Bull Lake, August 8, 1894 (No. 731); Laramie River, August 10, 1895 (No. 1665).

***Osmorrhiza nuda*, Torr. Pac. Rep. iv, 93 (1857).**

In copses along most of our streams.

Garfield Peak, July 29, 1894 (No. 650); Centennial Valley, August 19, 1895 (No. 1722).

***Cymopterus montanus*, T. & G. Fl. N. A. i, 624 (1840).**

One of the earliest plants on the plains and hills.

Laramie, May 7, 1894 (No. 9); specimens from previous years also in the herbarium.

***Ligusticum apiifolium*, Benth. & Hook. Gen. Pl. i, 912.**

A species with handsome foliage, quite rare.

Union Pass, August 11, 1894 (No. 832).

***Ligusticum filicinum*, Watson, Proc. Am. Acad. xi, 140.**

These specimens were not secured until after most of the fruit had fallen off, but the remaining fruits and foliage made satisfactory determination possible.

Gros Ventre river, August 18, 1894 (No. 1095).

***Ligusticum scopulorum*, Gray, Proc. Am. Acad. vii, 347 (1868).**

Fine specimens were collected at an unusual altitude, nearly 11,000 ft.

La Plata Mines, August 23, 1895 (No. 1784).

Ligusticum, sp.

The plants represented by numbers 1610 and 1655 are too immature to render determination certain, but Dr. Rose, to whom they were submitted, thinks it probable they are distinct species.

Oreoxis humilis, Raf.

Rare; Cummins, July 30, 1895 (No. 1431).

Selinum Grayi, C. & R.

In wet places at high elevations.

La Plata Mines, August 21, 1895 (No. 1776).

Angelica pinnata, Watson, King's Rep. v, 126 (1871).

Infrequent; along streams at 7,000-8,000 ft.

Upper Wind River, August 10, 1894 (No. 755).

Peucedanum graveolens, (?) Watson, King's Rep. v, 128 (1871). *P. Kingii*, Wats.

The material is scanty and over-ripe, but there is little doubt as to the correctness of the determination.

Garfield Peak, July 29, 1894 (No. 649).

Peucedanum nudicaule, Nutt. T. & G. Fl. N. A. i, 627 (1840).

Everywhere in the foothills, the naked scapes shooting up almost before the snow is off the ground.

Laramie, May 4, 1894 (No. 6); also on Horse Creek, June 6, 1893.

Peucedanum simplex, Nutt. Wats. King Rep. v, 129 (1871).

Only a few specimens secured.

Union Pass, August 11, 1894 (No. 822).

Pastinaca sativa, L. Sp. Pl. 262 (1753).

Introduced at Cheyenne, where it was collected by B. C. Buffum, August 11, 1891. *Wild Parsnip*.

Heracleum lanatum, Michx. Fl. Bor. Am. i, 166 (1863).

On all streams, growing in the greatest profusion in the thickets at the water's edge.

Horse Creek, July 11, 1891; collected also high up on the Teton, August 21, 1894 (No. 1055).

ARALIACEÆ.

Aralia hispida, Vent. Hort. Cels. t. 41.

The herbarium contains a single specimen collected by B. C. Buffum in 1892, no locality given. It most probably is from the north-eastern part of the state.

CORNACEÆ.***Cornus stolonifera*, Michx. Fl. i, 92 (1803).**

An exceedingly common shrub in thickets on most of our streams.

Wallace Creek, July 29, 1894 (No. 663); Little Sandy, August 31, 1894 (No. 1125); Table Mountain, July 1, 1895 (No. 1407).

CAPRIFOLIACEÆ.***Sambucus melanocarpa*, Gray, Proc. Am. Acad. xix, 76 (1883).**

Frequent in rocky canons throughout the state.

Telephone Canon, June 15, 1894, (No. 253); Union Peak, August 13, 1894 (No. 1026); Centennial Valley, August 18, 1895 (No. 1690).

***Viburnum pauciflorum*, Pylaie, T. & G. Fl. N. A. ii, 17 (1841).**

Reported abundant near Sundance, specimens communicated by Mr. H. J. Chassel, September 1, 1895.

***Symphoricarpos occidentalis*, Hook. Fl. Bor. Am. i, 285 (1834).**

On sandy creek banks as an undershrub in the thickets.

Blue Grass Creek, July 8, 1894 (No. 324); Laramie Peak, August 8, 1895 (No. 1565).

***Symphoricarpos oreophilus*, Gray; Journ. Linn. Soc. & Bot. Calif.**

In the hills and mountains only at considerable elevations.

Casper Mountain, July 26, 1894 (No. 608); Cummins, July 29, 1895 (No. 1509).

***Symphoricarpos racemosus pauciflorus*, Robbins, Gray, Man. Ed. 5, 203 (1867). *S. pauciflorus*, (Robbins) Britton.**

A few specimens secured on the eastern slope of the Tetons, August 21, 1894 (No. 958).

***Lonicera involucrata*, Banks, Richards. Bot. App. Ed. 2, 6 (1823).**

Very common on little mountain streams; frequently called *Grouse Berries*.

Upper Wind River, August 10, 1894 (No. 758); Cummins, July 30, 1895 (No. 1482).

***Lonicera Utahensis*, Wats. Bot. King Surv. 133 (1871).**

This I think to be very rare in the state.

Teton Mountains, August 21, 1884 (No. 934).

RUBIACEÆ.

***Galium boreale*, L. Sp. Pl. 108 (1753).**

On every fertile mountain hillside and every valley in the greatest profusion.

Sybill Creek, July 8, 1894 (No. 343); Table Mountain, June 30, 1895 (No. 1384).

***Galium trifidum*, L. Sp. Pl. 105 (1753).**

Common in wet places, as on the occasionally flooded banks of slow flowing streams.

Silver Creek, August 24, 1894 (No. 1115); Centennial Valley, August 19, 1895 (No. 1763).

***Galium triflorum*, Michx. Fl. i, 80 (1803).**

Not common, collected on a wet, shaded hillside.

Centennial Valley, August 17, 1895 (No. 1693).

VALERIANACEÆ.

***Valeriana edulis*, Nutt.; Torr & Gray, Fl. ii, 48 (1841).**

Very plentiful in the wet meadows bordering the Laramie River. Fisher Ranch, June 19, 1894 (No. 262).

***Valeriana Sitchensis*, Bong. Veg. Sitch. 145.**

Fine specimens were secured at Clark's, but not observed elsewhere.

Upper Wind River, August 10, 1894 (No. 793).

***Valeriana sylvatica*, Banks; Richards Bot. App. 730 (1823).**

On wooded hillsides and in wet valleys in the Laramie Mountains. This species is very abundant.

Telephone Canon, June 15, 1894 (No. 228). Observed in a large number of other places.

COMPOSITÆ.

***Brickellia grandiflora*, Nutt. Trans. Am. Phil. Soc. vii, 287 (1841).**

Coleosanthus grandiflorus, (Hook.) Kuntze.

Frequent on hillsides near the Platte and its tributaries.

Fairbanks, July 10, 1894 (No. 423); Cummins, July 30, 1895 (No. 1687).

***Kuhnia eupatorioides*, L. Sp. Pl. Ed. 2. 1662 (1763).**

Infrequent; Laramie, September 1893.

- Kuhnia eupatorioides corymbulosa**, T. & G. Fl. N. A. ii, 78 (1841).
K. glutinosa, Ell.
 Probably confined to the eastern part of the state.
 Cliffs, near Cold Spring, July 14, 1894 (No. 457).
- Liatris punctata**, Hook. Fl. Bor. Am. i: 306, t. 55 (1833). *Lacinaria punctata*, (Hook.) Kuntze.
 Abundant in the northern part of Albany and Laramie counties.
 Wheatland, June 30, 1892, B. C. Buffum; Laramie Peak, August 7, 1895 (No. 1564).
- Liatris scariosa**, Willd. Sp. Pl. iii, 1635 (1804). *Lacinaria scariosa*, (L.) Hill.
 The range of this is about the same as the last but it prefers the rich loam of the valleys.
 Inyan Kara Divide, August 30, 1892, B. C. Buffum; Laramie Peak, August 8, 1895 (No. 1651).
- Liatris squarrosa intermedia**, D C. Prodr. v, 129 (1836). *Lacinaria squarrosa intermedia*, (Lindl.) Porter.
 Apparently quite local, in the northern part of Laramie county.
 Rawhide Creek, September 4, 1892, B. C. Buffum; Mexican Mines, July 20, 1894 (No. 588).
- Gutierrezia Euthamiæ**, T. & G. Fl. N. A. ii, 193 (1841). *G. Sarothrae*, (Pursh) Britton & Rusby.
 The most prevalent of our small undershrubs, particularly on the plains.
 University Campus, September 12, 1894 (No. 1133); frequent also on the plains of the Platte.
- Grindelia squarrosa**, Dunal in D C. Prodr. v, 315 (1836).
 Abundant in all parts of the state thus far traversed.
 Meadow Creek, August 9, 1894 (No. 777); Laramie, September 16, (No. 1148).
- Chrysopsis villosa**, Nutt. Gen. ii, 151 (1818).
 In this polymorphous species, with so many intermediate forms, it becomes difficult to say which should receive varietal names. Some of the specimens before me, however, are typical.
 Platte River, July 14, 1894 (No. 481); Hartville, July 18, 1894 (No. 585), a very villous form.

Chrysopsis villosa canescens, Gray, Syn. Fl. 123 (1886).

The commoner form in the north-western part of the state.

Gros Ventre River, August 16, 1894 (No. 1084); also observed in the Teton Mountains.

Chrysopsis villosa hispida, Gray, Proc. Acad. Phila. 1863, 65.

This is the form prevalent on the plains about Laramie, State Fish Hatchery grounds, July 1891, B. C. Buffum.

Chrysopsis villosa viscida, Gray, Syn. Fl. 123 (1886).

A characteristic mountain form common in the Medicine Bow range.

Cummins, July 28, 1895 (No. 1497).

Aplopappus acaulis, Gray, Proc. Am. Acad. vii, 353.

Frequent and abundant on the Laramie Plains and in the foothills.

Laramie Hills, June 1893; plains, west of Laramie, June 9, 1895 (No. 1250).

Aplopappus acaulis glabratus, Eaton, Bot. King's Exp. 161.

Laramie, 1893. The month not noted, but it was probably collected late in the season.

Aplopappus armerioides, Gray, Syn. Fl. i, 132 (1886). *Stenotus armerioides*, Nutt.

Found only on the "red hills" near Laramie.

June 15, 1894 (No. 227).

Aplopappus Fremonti, Gray, near var. **Wardi**, Gray, Syn. Fl. i. 128.

This fine form I at first thought must be a *Bigelovia* as it was rayless, but Mr. M. L. Fernald, who kindly made comparison for me with the specimens in the Harvard herbarium, finds that my specimens correspond closely with Ward's the main difference being that mine have longer pappus.

Plains, ten miles north of Laramie, August 1, 1895 (No. 1553).

Aplopappus lanceolatus, T. & G. Fl. ii, 241.

Frequent on grassy slopes and in the valleys of the foothills.

Laramie, August 1894; Poison Spider Creek, July 27, 1894 (No. 624).

Aplopappus Lyalli, Gray, Proc. Acad. Phila. 1863, 64.

Quite typical specimens of this fine alpine plant were secured.

Union Pass, August 13, 1894 (No. 1012).

lanceolata that perfectly accords with it. This I cut out and place here

Rock Springs, August 9, 1895, E. L. Greene; Poison Spider Creek, July 26, 1894 (No. 618).

Solidago Canadensis, L. Sp. Pl. 878 (1753).

Probably confined to the lower altitudes of the eastern part of the state.

C. Y. Ranch, Big Muddy, July 23, 1894 (No. 597).

Solidago elongata, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 328 (1841).

Frequent on the lower courses of mountain streams.

Big Muddy Creek, July 24, 1894 (No. 641); Cummins, July 27, (No. 1479). Also observed on Meadow Creek, 1894.

Solidago humilis nana, Gray, Proc. Am. Acad. viii, 389.

Infrequent, 9,000 ft. and upward.

Centennial Valley, August 18, 1895 (No. 1680).

Solidago Missouriensis, Nutt. Journ. Acad. Phila. vii, 32 (1834).

The species is much rarer with us than the following varieties.

Laramie Peak, August 8, 1895 (No. 1629).

Solidago Missouriensis extraria, Gray, Proc. Am. Acad. xvii, 195.

This seems to be the form on the western slope of the Rockies.

Bacon Creek, August 15, 1894 (No. 912).

Solidago Missouriensis montana, Gray, l. c.

Very common in dry, clayey ravines and on the adjoining hillsides near the Platte and its tributaries.

Uva, July 10, 1894 (No. 382); Cottonwood Canon, August 5, 1895 (No. 1571).

Solidago multiradiata, Ait. Hort. Kew. iii, 218 (1789).

Frequent in the mountains.

Warm Spring Creek, August 10, 1894 (No. 800); LaPlata Mines, August 22, 1895 (No. 1771).

Solidago multiradiata scopulorum, Gray, Proc. Am. Acad. xvii, 191 (1882).

Only a few specimens were secured, at high elevations, probably 10,000 ft.

Teton Mountains, August 22, 1894 (No. 955).

Solidago nana, Nutt. Trans. Am. Phil. Soc. vii, 327.

Not frequent. Upper Wind River, August 10, 1894 (No. 765).

***Solidago rigida*, L. Sp. Pl. 880 (1753).**

Not observed by the writer, but good specimens from the north-eastern part of the state.

Suggs Road, August 15, 1892, B. C. Buffum; Sheridan Experiment Farm, September 1895, J. F. Lewis.

***Townsendia grandiflora*, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 306 (1841).**

Frequent on the sandy plains in the eastern part of the state.

Uva, July 9, 1894 (No. 385); Pole Creek, June 30, 1895 (No. 1366).

***Townsendia sericea*, Hook. Fl. Bor. Am. 119 (1834). *T. exscapa*, (Richards) Porter.**

So far as my observation goes, this is the very earliest flower of southeastern Wyoming. Abundant on the plains and in the foothills.

Collected May 5, 1894 (No. 7); observed on several years as early as the first week in April.

***Aster adscendens*, Lindl. Hook. Fl. Bor. Am. ii, 8 (1834).**

I find this as variable as it is common in the state.

Nearly typical specimens from Bacon Creek, Silver Creek, Sweetwater River and Laramie, late August and September (Nos. 1052, 1110, 1196 and 1149).

A very peculiar form from Myersville, September 5, 1894 (No. 1193). This will probably prove to be a good variety at least. Other specimens from Laramie Peak are not typical, but for the present they are placed here. (Nos. 1561 and 1639).

***Aster adscendens frondeus*, Gray.**

The citation for this name, which was communicated to me by Prof. Greene, I am unable to give. The specimens indicate a good variety at least.

Bacon Creek, August 25, 1894 (No. 1049).

***Aster adscendens*, Lindl. var. ?**

Three quite different forms I have listed as possible varieties—No. 892 from Bacon Creek, Nos. 964 and 1092 from Gros Ventre River.

***Aster canescens*, Pursh. Fl. Am. Sept. 547 (1814). *Machæranthera canescens*, Gray.**

The specimens seem hardly typical, but neither are they referable to any of the established varieties.

Bacon Creek, August 15, 1894 (No. 904); Gros Ventre River, August 17, 1894 (No. 1089).

Aster canescens latifolius, Gray, Torr. in Emory Rep. 141.

Infrequent; on eastern slope of partially wooded mountain side. Laramie Peak, August 7, 1895 (No. 1636).

Aster canescens viridis, Gray, Syn. Fl. 206 (1886).

A very abundant plant on the Laramie Plains, in places a troublesome weed.

University Campus September 15, 1894 (No. 1150).

Aster commutatus, Gray, Syn. Fl. 185 (1884). *A. incanopilosus*, (Lindl.) Sheldon.

Exceedingly abundant everywhere, some of its forms shading off into *A. multiflorus*.

Big Muddy Creek, July 23, 1894 (No. 598); Laramie, October 10, 1894 (No. 1170).

Aster conspicuus, Lindl. Hook. Fl. Bor. Am. ii, 7 (1840).

Infrequent; on a partially wooded slope in the Gros Ventre Mountains, near the Gros Ventre River, August 22, 1894 (No. 1089).

Aster elegans, T. & G. Fl. N. A. ii, 159.

This beautiful species seems to belong to the northeastern part of the state, in partially open hillsides.

Union Pass, August 11, 1894 (No. 826); Gros Ventre, August 22 (No. 1068).

Aster Engelmanni, Gray, Bot. King Surv. 144 (1871).

In a rather open copse on the banks of a canon stream. Centennial Valley, August 17, 1895 (No. 1691).

Aster foliaceus, Lindl. DC. Prodr. v, 228 (1836).

The specimens are typical except that they are somewhat dwarf. Wheatland, July 14, 1891, B. C. Buffum.

Aster foliaceus Burkei, Gray, Syn. Fl. 193 (1884).

Three good varieties of this at hand, this one from Little Sandy Creek, August 30, 1894 (No. 1132).

Aster foliaceus Eatoni, Gray, Syn. Fl. 194 (1884).

East Fork, August 25, 1894 (No. 1118).

***Aster foliaceus frondeus*, Gray, Syn. Fl. 193 (1884).**

Centennial Valley, August 25, 1895 (No. 1859).

***Aster Fremontii*, Gray, T. & G. Fl. N. A. ii, 503.**

No data on this specimen except collected near Laramie, October 3, 1891, by B. C. Buffum.

***Aster frondosus*, T. & G. Fl. N. A. ii, 165. *Brachyactis frondosa*, Gray.**

Frequent in low, wet ground, especially in alkali soil, on the hummocks in alkali bogs.

Typical specimens from Laramie, September 7, 1895 (No. 1867); specimens from Seven Mile Lake, October 15, 1894 (No. 1159), remarkable for their size and the great number of large flowers.

***Aster glaucus*, T. & G. Fl. N. A. ii, 172.**

In the foothills of all the mountain ranges yet collected.

Big Wind River, August 10, 1894 (No. 772); Laramie, September 30, 1894 (No. 1151); Laramie Peak, August 7, 1895 (No. 1590).

***Aster lævis Geyeri*, Gray, Syn. Fl. 183 (1884).**

Collected by B. C. Buffum, Eagle Rock Canon, August 22, 1892.

***Aster integrifolius*, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 291 (1841).**

Belonging to the western or Pacific slope, observed only on the west side of Union Pass, August 13, 1894 (No. 1032).

***Aster Lindleyanus*, T. & G. Fl. N. A. ii, 122.**

It was quite a surprise to find this species so far to the south and west.

Laramie Peak, August 6, 1895 (No. 1592).

***Aster multiflorus*, Ait. Hort. Kew. iii, 203 (1789).**

Common throughout the state and quite variable as to habit, hirsuteness and size of flowers.

Big Muddy Creek, July 24, 1894 (No. 642); reported from Sheridan as a weed on the Experiment Farm.

***Aster Parryi*, Gray, Am. Nat. viii, 212.**

This beautiful large flowered species is found in the greatest abundance in some parts of the Laramie Plains as is its congener *A. xylorrhiza*. Usually in separate districts but occasionally striving for the occupancy of the same hillside. Hybrids, I think, sometimes occur, for specimens are found with the characters of both species well blended. Preferring a red clay soil with a percentage of alkali in it.

Carbon, June 18, 1894 (No. 256), Miss Lily Boyd; Laramie Plains, June 20, 1895 (No. 1315).

Aster ptarmicoides, T. & G. Fl. N. A. ii, 160 (1841).

Rare; typical specimens from Bald Mountain, August 16, 1892, B. C. Buffum.

Aster pulchellus, Eaton, Bot. King Exp. 143.

This elegant alpine form occurs at least in the two principal ranges in the northern part of the state.

Bald Mountain, August 8, 1892, B. C. Buffum; Union Peak, August 13, 1894 (No. 1016).

Aster salicifolius, Ait. Hort. Kew. iii, 203.

From Jackson's Hole, near the base of the Teton Mountains, August 21, 1894 (No. 1065).

Aster tanacetifolius, H B K. Nov. Gen. & Sp. iv, 95 (1820).

Frequent on the sandy plains of the Platte. Uva, July 10, 1894 (No. 443). Observed in many other places.

Aster xyloirrhiza, T. & G. Fl. N. A. ii, 158

This grows even more profusely than the above mentioned *A. Parryi*, but prefers soil with less alkali. Sandy clay ridges on the height of land between streams.

Laramie Plains, June 20, 1895 (No. 1315).

Erigeron acris, L. Sp. Pl. 863 (1753).

Infrequent and alpine; Laramie Peak, August 7, 1895 (No. 1621).

Erigeron armerifolius, D C. Prodr. v, 291 (1836).

Quite frequent along stream banks.

Head of Green River, August 14, 1894 (No. 908); Cummins, July 29, 1895 (No. 1480).

Erigeron cœspitosus, Nutt. Trans. Am. Phil. Soc. vii, 307 (1841).

Frequent on dry stony hillsides in the Laramie Mountains.

Blue Grass Creek, July 9, 1894 (No. 334); Cummins, July 30, 1895 (No. 1496).

Erigeron Canadensis, L. Sp. Pl. 863 (1753).

Sybill Creek, July 9, 1894 (No. 298); Whalen Canon, July 18, 1894 (No. 556).

Erigeron canus, Gray, Mem. Am. Acad. iv, 67 (1849).

My specimens of this are a little scanty and over ripe, but I think there is little doubt of the correctness of the determination.

Platte Canon, July 14, 1894 (No. 482).

Erigeron compositus, Pursh, Fl. ii, 535 (1814).

Observed only on a clayey, gravelly ridge at the head of Pole Creek, May 12, 1894 (No. 26); May 18, 1895 (No. 1217).

Erigeron compositus pinnatisectus, Gray, Proc. Am. Acad. xvi, 90 (1880).

In the Medicine Bow Mountains only as yet, 10,000 ft. and upward.

La Plata Mines, August 23, 1895 (No. 1816).

Erigeron trifidus, Hook. Fl. Bor. Am. ii, 17 (1834).

Near the summit of Laramie Peak, August 7, 1895 (No. 1612).

Erigeron corymbosus, Nutt. Trans. Am. Phil. Soc. vii, 308 (1841).

This fine mountain form is quite variable as to the number of heads. In three specimens from different localities I find the stems unicephalous, while only one has the typical corymbose arrangement.

Telephone Canon, June 15, 1894 (No. 234); Platte Hills, July 24, 1894 (No. 633); Union Pass, August 10, 1894 (No. 859); Centennial Hills, June 9, 1895 (No. 1290).

Erigeron Coulteri, Porter, in Fl. of Colo., 61.

Just a few fine specimens secured at Cummins, July 28, 1895 (No. 1524).

Erigeron divergens, T. & G. Fl. ii, 175 (1841).

Widely distributed, but not common.

Fine specimens from Snake River, Jackson's Hole, August 22, 1894 (No. 1053). Larger and more divergently branched plants from subalpine slopes on Laramie Peak, August 6, 1895 (No. 1635).

Erigeron flagellaris, Gray Mem. Am. Acad. iv, 68 (1849).

Immature and mature specimens present a very different appearance on account of the great lengthening of the stems without a corresponding increase in the number of leaves. Table Mountain, June 30, 1895 (No. 1386); Laramie Peak, August 6, 1895 (No. 1600).

Erigeron glabellus, Nutt. Gen. ii, 147 (1818). *E. asperus*, Nutt.

Our commonest *Erigeron*, everywhere abundant in wet meadows, somewhat variable.

Lander Creek, August 29, 1894 (No. 1117); Cummins, July 30, 1895 (Nos. 1454 and 1536). Specimens from several other localities.

Erigeron subtrinervis, Rydberg. *E. glabellus mollis*, Gray.

That this is worthy of the specific rank recently accorded it, I think no one will question.

Centennial Valley, August 17, 1895 (No. 1692).

Erigeron grandiflorus, Hook. Fl. ii, 123.

Bald Mountain, August 15, 1892, B. C. Buffum, specimens with rays almost white; La Plata Mines, August 24, 1895 (No. 1805), rays purple.

Erigeron leiomeris, Gray, Syn. Fl. 211 (1884).

Collected on the Grand Teton at about 10,000 ft., at the foot of rocky ledges, August 21, 1894 (No. 1054).

Erigeron macranthus, Nutt. Trans. Am. Phil. Soc. vii, 310 (1841).

In mountain parks and meadows at 8,000 ft. and upward.

Garfield Peak, July 29, 1894 (No. 647); Cummins, July 30, 1895 (No. 1535).

Erigeron pumilus, Nutt. Gen. ii, 147 (1818).

Frequent in sandy, grassy valleys in the Laramie Mountains.

Laramie Hills, June 7, 1894 (No. 169); Table Mountain, June 30, 1895 (No. 1339); observed in many other localities.

Erigeron radicans, Hook. Fl. ii, 17.

On dry, stony ridges and subalpine table lands.

State Fish Hatchery grounds, Laramie, May 28, 1892, B. C. Buffum; Table Mountain, June 2, 1894 (No. 143).

Erigeron salsuginosus, Gray, Proc. Am. Acad. xvi, 93 (1880).

Wyoming must be the natural home of this splendid species, judging by the luxuriance of its growth. Superb specimens with heads two inches in diameter are of frequent occurrence along our mountain streams.

Union Pass, August 12, 1894 (No. 895); Centennial Hills, August 16, 1895 (No. 1775).

Erigeron strigosus, Muhl. Willd. Sp. Pl. iii, 1956 (1804). *E. ramosus*, (Walt.) B. S. P.

Infrequent, Union Pass, August 11, 1894 (No. 851).

Erigeron uniflorus, L. Sp. Pl. 864 (1753).

This, with us, alpine form varies greatly as to size and hirsuteness.

Specimens from Teton Mountains, August 22, 1894 (No. 969), are only 1-2 inches high, the involucre hirsute with sparse light

colored hairs. Those from the Medicine Bow Mountains, August 23, 1895 (No. 1772) are 4-6 inches high, stems bearing 4-6 leaves; involucre densely black lanate, rays white, heads 1 inch in diameter. I suggest the varietal name *melanocephalus* for this form.

Erigeron ursinus, Eaton, Bot. King's Exp. 148 (1871).

On rocky hills and ledges, 7,000-11,000 ft., successively throughout the season.

Table Mountain, June 2, 1894 (No. 144); La Plata Mines, August 23, 1895 (No. 1795).

Filago depressa, Gray, Proc. Am. Acad. xix, 3.

Not having seen an authentic *F. depressa*, I give the above determination with some reservation. In a gravelly hollow near the Little Laramie River, Centennial Valley, August 19, 1895 (No. 1751).

Antennaria alpina, Gærtn. Fr. & Sem. ii, 410 (1791).

Frequent, on dry hillsides.

Union Pass, August 11, 1894 (No. 853); Centennial Valley, June 9, 1895 (No. 1265).

Antennaria Carpathica pulcherrima, Hook. Fl. i, 329 (1834).

Probably throughout the state, in the rich soil of thickets.

Pole Creek, June 9, 1894 (No. 110); Union Pass, August 12, 1894 (No. 819).

Antennaria dioica, Gærtn. l. c.

Of this variable species we have our full share of forms. Laramie, Inyan Kara Divide, Wind River and Green River are places from which specimens are at hand (Nos. 762 and 885).

Antennaria dioica congesta, D C. Prodr. vi, 289.

This is of frequent occurrence, sometimes with closely depressed stems, at other times, stems several inches in length. Separable from the species by the compactness of the heads.

Laramie, June 28, 1894 (No. 291). A form with strikingly roseate bracts probably belongs here.

Antennaria racemosa, Hook. Fl. Bor. Am. i, 330 (1834).

Rare, and but a few specimens secured.

Union Pass, August 11, 1894 (No. 812).

Anaphalis margaritacea, Benth. & Hook. Gen. Pl. ii, 303 (1873).

Antennaria margaritacea, (L.) Hook.

In deeply shaded copses at the foot of mountains.

Tetons, August 21, 1894 (No. 959); Laramie Peak, August 8, 1895 (No. 1604).

Anaphalis margaritacea subalpina, Gray, Syn. Fl. 233 (1884).

On a rocky creek bed, Centennial Valley, August 16, 1895 (No. 1669).

Gnaphalium palustre. Nutt. Trans. Am. Phil. Soc. n. ser. vii, 404 (1841).

Not common. Wheatland, August 8, 1891, B. C. Buffum; Atlantic City, September 3, 1894 (No. 1186).

Iva axillaris, Pursh, Fl. Am. Sept. 743 (1814).

A troublesome weed in some localities; frequent on the sandy plains of the Platte.

Fairbanks, July 14, 1894 (No. 476). *Poverty Weed*.

Iva xanthifolia, Nutt. Trans. Am. Phil. Soc. (II) vii, 347 (1841).

Infrequent; Willow Creek, July 20, 1894 (No. 569); Cheyenne, August 11, 1891, B. C. Buffum.

Ambrosia psilostachya, D C. Prodr. v, 526 (1836).

An exceedingly annoying weed, its root-stocks making it almost impossible to destroy it by cultivation.

Wheatland, August 11, 1891, B. C. Buffum; Fairbanks, July 11, 1894 (No. 425); Laramie, September 30, 1894.

Ambrosia trifida, L. Sp. Pl. 987 (1753).

Infrequent in the state as yet.

Ford J. Ranch, on Willow Creek, July 21, 1894 (No. 563).

Franseria discolor, Nutt. Trans. Am. Phil. Soc. (II) vii, 345 (1841).

Gartneria discolor, (Nutt.) Kuntze.

One more of our weeds; "the more it is dug up the better it thrives."

University campus, July, 1891, B. C. Buffum; Hartville, July 15, 1894 (No. 550).

Franseria Hookeriana, Nutt. l. c. *Gartneria acanthicarpa*, (Hook.) Britton.

Frequent on sandy plains.

Inyan Kara Divide, August 30, 1892, B. C. Buffum; Big Wind River, August 5, 1894 (No. 707); Sweetwater River, September 9, 1894 (No. 1196).

- Xanthium Canadense**, Mill. Gard. Dict. Ed. 8, No. 2 (1768).
Not frequent; Cheyenne, August 9, 1891, B. C. Buffum; Platte River, July 14, 1894 (No. 485).
- Gymnolomia multiflora**, Benth. & Hook. Rothr. Bot. Wheeler Surv. 160 (1876).
Only from Snake River thus far, August 21, 1894 (No. 1064).
- Rudbeckia hirta**, L. Sp. Pl. 907 (1753).
Common throughout the state.
Specimens from Cheyenne, Laramie, Big Muddy Creek, and Cummins, (Nos. 600, 1144, 1459).
- Rudbeckia laciniata**, L. Sp. Pl. 906 (1753).
Common on streams in eastern part of the state.
Cottonwood Canon, August 5, 1895 (No. 1575).
- Lepachys columnaris**, T. & G. Fl. N. A. ii, 314 (1842).
This and the following variety are common on the plains and hills about the Platte
Uva, July 10, 1894 (No. 386).
- Lepachys columnaris pulcherrima**, T. & G. l. c.
This form maintains itself pretty uniformly in given areas, so seems entitled to varietal name.
Willow Creek, July 20, 1894 (No. 570).
- Balsamorhiza sagittata**, Nutt. Trans. Am. Phil. Soc. vii, 349 (1841).
Occasionally growing in the greatest profusion in dry, stony ravines.
Laramie Hills, by B. C. Buffum, June 24, 1892; June 9, 1894 (No. 213).
- Balsamorhiza macrophylla**, Nutt. Trans. Am. Phil. Soc. vii, 350 (1841).
Very rare, but one specimen found.
Union Pass, August 10, 1894 (No. 921).
- Wyethia amplexicaulis**, Nutt. Trans. Am. Phil. Soc. vii, 349 (1841).
Infrequent; Laramie Hills, June 21, 1891, B. C. Buffum; Union Pass Hills, August 11, 1894 (No. 816).
- Helianthus annuus**, L. Sp. Pl. ii, 904 (1753).
A common weed in some localities.
Cheyenne, August 11, 1891, B. C. Buffum; Fairbanks, July 12, 1894 (No. 432).

- Helianthus giganteus**, L. Sp. Pl. 905 (1753).
Near streams and in wet bottoms; not frequent.
Muskrat Creek, July 30, 1894 (No. 684); Laramie, October 6, 1894 (No. 1169).
- Helianthus Nuttallii**, T. & G. Fl. N. A. ii, 324 (1842).
Secured only west of the Wind River Mountains.
Gros Ventre River, August 16, 1894 (No. 1083).
- Helianthus pumilus**, Nutt. Trans. Am. Phil. Soc. vii, 366.
Frequent on dry slopes and hilltops.
Platte River Hills, July 14, 1894 (No. 501); also from Casper.
- Helianthus rigidus**, Desf. Cat. Hort. Paris. Ed. 3, 184 (1813).
Whalen Canon, July 18, 1894 (No. 528); Laramie Peak, August 6, 1895 (No. 1578).
- Helianthella quinquenervis**, Gray, Proc. Am. Acad. xix, 10.
In the mountains, in open places near streams.
Bald Mountain, by B. C. Buffum; Union Pass, August 10, 1894 (No. 803); Laramie Peak, August 6, 1895 (No. 1654).
- Thelesperma gracile**, Gray, Kew. Journ. Bot. i, 252 (1849).
Frequent on the hills near the Platte River.
Near Fort Laramie by B. C. Buffum; Blue Grass Hills, July 8, 1894 (No. 321).
- Bidens frondosa**, L. Sp. Pl. 832 (1753).
Frequent in the eastern part of the state.
Wheatland, September 1892; Sheridan Experiment Farm, September 1895, J. F. Lewis.
- Bidens cernua**, L. Sp. Pl. 832 (1753).
In wet places about Wheatland, September 1892, B. C. Buffum.
- Madia glomerata**, Hook. Fl. ii, 24.
A rare plant; in dry rich loam soil.
Big Wind River, August 2, 1892, B. C. Buffum; Laramie Peak, August 8, 1895 (No. 1593).
- Chaenactis Douglasii**, Hook. & Arn. Bot. Beechy. 354 (1840-41).
On abrupt stony clay hills.
Mouth of Bacon Creek, August 15, 1894 (No. 909); Cummins, July 25, 1895 (No. 1439).
- Chaenactis Douglasii alpina**, Gray, Syn. Fl. 341 (1884).
On subalpine stony hilltops; easily distinguished from the species by its striking rosette of radical leaves and its smaller size.

Garfield Peak, July 29, 1894 (No. 653); Cummins, July 26, 1895 (No. 1438).

Hymenopappus filifolius, Hook. Fl. Bor. Am. i, 317 (1833).

Frequent on the dry slopes of the Platte and Laramie River hills at 5,000-7,000 ft.

Sybill Creek, July 7, 1894 (No. 328); Table Mountain, June 29, 1895 (No. 1369).

Hymenopappus ligulæflorus, n. sp.

Perennial from a multicapital caudex, each division bearing one leafy stem, 5-8 inches high, glabrous but for some floccose wool on the crown of caudex; leaves simply pinnate into about five linear divisions, impressed punctate; heads few, corymbosely cymose, about $\frac{1}{3}$ inch high; involucre bracts oblong, hirsute-villous on the margins, resinous-atomiferous as are also the corollas, the whole strong scented; rays 6-8, $\frac{1}{2}$ inch long; lobes of disk corollas very short and erect; achenes short villous; pappus of thin acuminate paleæ, in this respect allying it more closely to *Hymenothrix*; flowers yellow.

Mr. L. Fernald, assistant in Gray Herbarium, who kindly examined it for me, reports it as a form of *H. filifolius*, but I cannot see why it should be left there.

Collected on the north Laramie Plains, about six miles from Owen, August 5, 1895 (No. 1573).

Bahia chrysanthemoides, Gray, Proc. Am. Acad. xix, 28.

Noted at Laramie Peak only, August 6, 1895 (No. 1634).

Bahia oppositifolia, Nutt. T. & G. Fl. N. A. ii, 376 (1842).

Common on the dry, sandy plains of the Platte; July 1894 (Nos. 332 and 602).

Eriophyllum cæspitosum, (Dougl.) Lindl. Bot. Reg. xiv, 1167 (1828).

Probably confined to the northwestern part of the state.

B. C. Buffum, in 1892 without data; Gros Ventre River, August 18, 1894 (No. 1099).

Eriophyllum cæspitosum leucophyllum, Gray, Proc. Am. Acad. xix, 25.

Very rare, in dry stony ravine.

Warm Spring Creek, Union Pass, August 10, 1894 (No. 801).

Dysodia chrysanthemoides, Lag. Nov. Gen. et Sp. 29 (1816). *D. papposa*, (Vent.) A. S. Hitchc.

Common in the eastern part of the state.

From Wheatland, by B. C. Buffum, August 11, 1891; Platte River, July 14, 1894 (No. 499).

Helenium autumnale, L. Sp. Pl. 886 (1753).

Very frequent on river bottoms.

Popo Agie River, August 1, 1894 (No. 736); Ione Ranch, August 10, 1895 (No. 1664).

Helenium Hoopesii, Gray, Proc. Acad. Phil. 65 (1863).

Infrequent; Union Pass, August 11, 1894 (No. 841).

Gaillardia aristata, Pursh, Fl. ii, 573.

Frequent and quite variable especially as to foliage. Probably throughout the state.

Platte River Hills, July 11, 1894 (No. 417); Pole Creek, June 27, 1895 (No. 1326).

Actinella acaulis, Nutt. Gen. ii, 173.

Very frequent indeed in various forms, the earlier individuals scapeless as well as stemless.

Laramie Hills, June 7, 1894 (No. 177); Table Mountain, June 27, 1895 (No. 1300).

Actinella glabra, (Nutt.) n. sp.

If ever a plant deserved specific rank, this one does. Many as are the forms of *A. acaulis*, by necessity, there is no excuse for making this one of them. It is clearly separated from that by the much longer branches of the caudex, which are closely covered with the persistent bases of dead petioles, all of which are completely enveloped in long, densely matted wool, brownish-red, except at the summit, where it becomes continuous with the white persistent wool of the scape and involucre. Leaves longer, glabrous and strongly impressed-punctate; heads large, 1 inch or even more across. Roots enormous, sometimes several feet in length; the multicapital caudex forming raised rounded tufts 6-12 inches across, which very early in the spring become covered with fine yellow heads. *A. acaulis glabra*, Gray. *A. glabra*, Nutt.

Exceedingly abundant in the Laramie Hills, where it is in blossom from April to June (Nos. 36 and 1233).

- Actinella grandiflora***, T. & G. Bost. Journ. Nat. Hist. Soc. v, 110.
Rare; probably strictly alpine.
On the naked summits of the Medicine Bow Mountains, August 23, 1895 (No. 1822).
- Actinella Richardsonii***, Nutt. Trans. Am. Phil. Soc. vii, 379.
Rare; only a few specimens secured.
Centennial Hills, August 19, 1895 (No. 1688).
- Actinella scaposa linearis***, Nutt. Trans. Am. Phil. Soc. vii, 378.
This is a common species in sandy, grassy valleys in the hills.
Table Mountain, June 2, 1894 (No. 91); June 29, 1895 (No. 1341).
- Achillea millefolium***, L. Sp. Pl. ii, 899 (1753).
From the summits of our mountains to our lowest valleys.
Sybille Creek, July 8, 1894 (No. 409); Wind River Mountains, August 8, 1894.
- Anthemis cotula***, L. Sp. Pl. 894 (1753).
Introduced in Laramie and possibly elsewhere but apparently not thriving. It would soon disappear were it not reintroduced.
Laramie, October 1894 (No. 1160).
- Tanacetum capitatum***, T. & G. Fl. N. A. ii, 415.
Infrequent; Laramie, in the "red hills," June 15, 1894 (No. 226).
- Artemisia biennis***, Willd. Phytogr. 11 (1794).
Very common in waste ground about the city.
Laramie, September 18, 1894 (No. 1145).
- Artemisia cana***, Pursh. Fl. ii, 521.
This seems to belong to the western slope, where, in the fertile creek valleys, it is the prevailing species.
Bacon Creek, August 25, 1894 (No. 1042); Lewiston, September 5, 1894 (No. 1183).
- Artemisia Canadensis***, Michx. Fl. Bor. Am. ii, 129 (1803).
Of frequent occurrence on the Big Wind River; by B. C. Buffum, August 2, 1892; August 5, 1894 (No. 710); Laramie Peak, August 6, 1895 (No. 1660).
- Artemisia dracunculoides***, Pursh, Fl. Am. Sept. 742 (1814).
Infrequent in the parts of the state collected; Eagle Rock Canon, August 22, 1892, B. C. Buffum.

***Artemisia filifolia*, Torr. Ann. Lyc. N. Y. ii, 211 (1827).**

This fine species is also rare unless it be in the northeastern part of the state.

Inyan Kara Divide, August 30, 1892, B. C. Bcflum.

***Artemisia frigida*, Willd. Sp. Pl. iii, 1838 (1804).**

Perhaps the commonest of our long list of "sages," appearing everywhere on the dry plains and in the hills.

Union Pass, August 10, 1894 (No. 861); University campus, September 16, 1894 (No. 1135); Sheridan Experiment Farm, September 1895.

***Artemisia Ludoviciana*, Nutt. Gen. ii, 143 (1818).**

Quite variable, differing especially as to foliage and compactness of panicle. On creek banks throughout the state.

Laramie, October 6, 1894 (No. 1171); Laramie Peak, August 5, 1895 (No. 1643).

***Artemisia Ludoviciana integrifolia*, n. var.**

Leaves all entire, large, (1-3 inches long), narrowly lanceolate, margins revolute; panicle strict, heads fewer and larger than in the species.

Willow Creek, July 20, 1894 (No. 568).

***Artemisia Mexicana*, Willd. Spreng. Syst. iii, 490.**

Infrequent; Sweetwater Stage Station, September 9, 1894 (No. 1181).

***Artemisia Norvegica*, Fries, in Liljeb. Fl. (1815).**

A handsome plant, infrequent, alpine.

Union Peak, August 12, 1894 (No. 897).

***Artemisia scopulorum*, Gray, Proc. Acad. Phila. 66 (1863).**

Probably in all our alpine regions.

Union Peak, August 13, 1894 (No. 989); La Plata Mines, August 22, 1895 (No. 1779).

***Artemisia tridentata*, Nutt. Trans. Am. Phil. Soc. (II) vii, 398 (1841).**

This is the shrub that is generally designated by the term "sage brush," whereas the term sage is applied indiscriminately to the preceding. It is, perhaps, the most characteristic shrub of the Wyoming plains and valleys. Its presence indicates soil of good quality, reasonably free from alkali. Of very slow growth, but on

some creeks reaching the dignity of small trees and furnishing excellent fuel.

Boulder Creek, August 25, 1894 (No. 1111).

***Artemisia trifida*, Nutt. l. c.**

No specimens of this species are at hand but it is known to be in the state.

Noted by Prof. W. C. Knight, on Seminoe Mountains, May 6, 1896, at about 8,000 ft. altitude.

***Petasites sagittata*, Gray, in Brew. & Wats. Bot. Cal. i, 407 (1876).**

Tussilago sagittata, Pursh.

Rare; in a wet, boggy meadow.

Pole Creek, May 25, 1894 (No. 81).

***Arnica alpina*, Olin. Mon. Arn. Upsala (1799).**

Very abundant about Table Mountain, where it was collected June 2, 1894 (No. 148); June 30, 1895 (No. 1383).

***Arnica amplexicaulis*, Nutt. Trans. Am. Phil. Soc. vii, 408.**

Frequent in copses in fertile subalpine valleys.

Teton Mountains, August 21, 1894 (No. 933); Centennial Hills, August 19, 1895 (No. 1702).

***Arnica Chamissonis*, Less. Linnæa, vi, 317 (1831).**

Frequent in the mountains.

Pine Creek, by B. C. Bufum; Union Peak, August 13, 1894 (No. 995); La Plata Mines, August 23, 1895 (No. 1785).

***Arnica cordifolia*, Hook. Fl. Bor. Am. i, 331 (1833).**

Exceedingly abundant; in woods and copses in the mountains from their bases to their summits. Somewhat variable, the radical leaves often reduced and ovate rather than cordate.

Horse Creek June 9, 1894 (No. 215); Union Pass, August 10, 1894 (No. 871); also from the Centennial Valley.

***Arnica foliosa*, Nutt. Trans. Am. Phil. Soc. vii, 407.**

Probably rare; collected only on upper Wind River, August 10, 1894 (No. 766).

***Arnica foliosa incana*, Gray, Bot. Cal. i, 416 (1876).**

Specimens from Pine Creek, by Prof. B. C. Buffum, presumably nearly typical; others less so from Saratoga, July 2, 1893, by J. D. Parker.

Arnica latifolia, Bong. Veg. Sitch. 147.

A beautiful subalpine species, probably in all of our mountains. Bald Mountain, B. C. Buffum, in August 1892; Union Pass, August 11, 1894 (No. 836); noted in Medicine Bow Mountains.

Arnica longifolia, Eaton, Bot. King Exp. 186.

Decidedly rare; Teton Mountains, August 21, 1894 (No. 957).

Senecio amplexens taraxacoides, Gray, Proc. Acad. Phila. 67 (1863).

Very rare; only a few specimens from the Teton Mountains, August 22, 1894 (No. 987).

Senecio aureus, L. Sp. Pl. ii, 870 (1753).

This and many of its varieties are well represented in our flora. The individual variation is often so great that it is difficult to assign some specimens to any of the numerous varieties already created.

Specimens from Green River, August 26, 1894 (No. 1036), and Wind River, August 10, 1894 (No. 760) I think are nearly typical, as are also some from Beaver Creek and Laramie, by B. C. Buffum.

Senecio aureus borealis, T. & G. Fl. N. A. ii, 442.

On the rocky slopes of the Teton Mountains, August 21, 1894 (No. 979).

Senecio aureus croceus, Gray, Proc. Acad. Phila. 68 (1863)

This is a frequent form in subalpine meadows.

Union Pass, August 10, 1894 (No. 858); La Plata Mines, August 20, 1895 (No. 1753).

Senecio aureus obovatus, T. & G. Fl. N. A. ii, 442.

Typical specimens from Big Wind River, August 5, 1894 (No. 704); doubtful ones from La Plata Mines, August 23, 1895 (No. 1769).

Senecio Balsamitæ (?) Muhl. Willd. Sp. Pl. iii, 1998 (1804).

I think there is little doubt of the two sets of specimens before me belonging here; they lack the root leaves upon which the description partly hinges, but seem normal otherwise.

Eagle Rock Canon, August 2, 1892, B. C. Buffum; Cummins, July 30, 1895 (No. 1492).

Senecio canus, Hook. Fl. Bor. Am. i, 333 (1834).

This strongly marked species is of frequent occurrence in the state. Our specimens are large, stoloniferous and slightly decumbent at base.

Union Pass, August 10, 1894 (No. 761); Table Mountain, June 30, 1895 (No. 1364).

Senecio crassulus, Gray, Proc. Am. Acad. xix, 54.

Probably in the subalpine regions of all our mountains.

A large form in Union Pass, August 10, 1894 (No. 809); smaller and more typical, Union Peak, August 13, (No. 1027); La Plata Mines, August 21, 1895 (No. 1770).

Senecio Douglasii, D C. Prodr. vi, 429 (1837).

This is of frequent occurrence, the three main forms being represented: 1. Glabrous, stems branched, leaves broad, with broad, unequal lobes; rays long, narrow (6-10). This is probably the suppressed *Senecio fastigiatus*, Gray. 2. Slightly pubescent-tomentose stems paniculately branched only at summit; leaves pinnately parted into linear lobes, the rays few and inconspicuous. This form is Bentham's *Senecio longilobus*. 3. Glabrous, stems very numerous from a woody base, strict; leaves entire, linear; inflorescence a short cymose panicle; rays long and conspicuous. This is *Senecio Ridellii*, T. & G.

I see no reason why forms so distinct should not be kept separate. 1. From Pole Creek, July 1, 1895 (No. 1389); 2. Sybille Hills, July 8, 1894 (No. 302), and Cummins, July 27, 1895 (No. 1441); 3. Cummins, July 27, 1895 (No. 1440).

Senecio eremophilus, Richards. App. Frankl. Journ. Ed. 2, 31.

Infrequent; Cummins, July 29, 1895 (No. 1491).

Senecio Fendleri, Gray, Pl. Fendl. 108.

A very common form in stony clay hills.

Pole Creek, June 2, 1894 (No. 124); Centennial Valley, June 9, 1895 (No. 1297).

Senecio hydrophilus, Nutt.

Frequent, but never plentiful; in wet and sometimes boggy places.

Bacon Creek, August 15, 1894 (No. 915); Cummins July 28, 1895 (No. 1458).

Senecio integerrimus, Nutt. Gen. ii, 165.

Very frequent in fertile, open valleys in the mountains.

Union Pass, August 14, 1894 (No. 891); Teton Mountains, August 21, 1894 (No. 1002); Table Mountain, June 26, 1895 (No. 1333).

Senecio lugens, Richards. Bot. App. 748 (1823).

Very common and of many forms which probably are worthy of varietal distinction. The following numbers appear early on hillsides and valleys and are probably near the type:

Table Mountain, June 2, 1894 (No. 128); Centennial Valley, June 9, 1895 (No. 1305).

Senecio lugens foliosus, Gray, Bot. Cal. i, 413.

On hillsides, in rich loam soil among undershrubs.

Union Pass, August 13, 1894 (No. 999); Centennial Valley, June 9, 1895 (No. 1246).

Senecio lugens megalocephalus, n. var.

Radical leaves large, irregularly and coarsely dentate; cauline leaves small or wanting; stem branched from near the base into several slender branches 8-12 inches long, each bearing a few (3-5) large heads (5-8 lines high). The whole plant is very tardily glabrate. In thickets on moist hillsides.

Centennial Valley, June 9, 1895 (No. 1252).

Senecio rapifolius, Nutt.

Said to be a very rare plant.

Sweetwater River, September, 1894 (No. 1180); Laramie Peak, August 7, 1895 (No. 1589).

Senecio serra, Hook. Fl. Bor. Am. i, 333 (1834).

Infrequent; near Warm Spring Creek, August 10, 1894 (No. 771).

Senecio serra integrifolius, Gray, Syn. Fl. 387 (1884). *S. Andinum*, Nutt.

A rare plant; in the Union Pass hills, August 10, 1894 (No. 876).

Senecio triangularis, Hook. Fl. Bor. Am. i, 332 (1834).

On wet banks in copses in mountain canons.

Teton Mountains, August 21, 1894 (No. 936); Cummins, July 31, 1895 (No. 1519).

Senecio werneræfolius, Gray, Proc. Am. Acad. xix, 54.

Frequent in the "red hills" (Tertiary) about Laramie, June 15, 1894 (No. 224); Table Mountain, June 29, 1895 (No. 1379).

Tetradymia canescens, D C. Prodr. vi, 440 (1837).

On the dry plains of the Platte; Big Muddy Creek, July 23, 1894 (No. 605).

***Tetradymia canescens inermis*, Gray.**

While not separated from the species by any strong botanical characters, yet readily distinguished by foliage and general habit.

Wallace Creek, July 29, 1894 (No. 656).

***Onicus altissimus filipendulus*, Gray, Proc. Am. Acad. xix, 56.**

Specimens received from Sheridan Experiment Farm seem to belong to this variety, probably introduced with farm seeds. September, 1895.

***Onicus Americanus*, Gray, Proc. Am. Acad. xix, 56.**

In the dry foothills near the Laramie River; not frequent.

Cummins, July 29, 1895 (No. 1512).

***Onicus arvensis*, Hoffm. Deutch. Fl. Ed. 2, I: Part 2, 130 (1804).**

Carduus arvensis, (L.) Robs.

Thus far this, the *Canada Thistle*, has been reported from only one place in the state.

Specimens from Sheridan, September 1895, J. F. Lewis.

***Onicus Drummondii*, Gray, Proc. Am. Acad. x, 40. *Carduus pumilus*, Hook.**

Very frequent throughout the state.

Laramie, September, 1893: Union Pass, August 14, 1894 (No. 881); Cummins, July 27, 1895 (No. 1469).

***Onicus lanceolatus*, Hoffm. *Carduus lanceolatus*, L.**

Becoming plentiful in vacant lots and along the irrigation ditches.

***Onicus ochrocentrus*, Gray, Proc. Am. Acad. xix, 57 (1883).**

In dry, open ground in the hills; frequent.

Laramie Hills, July 7, 1894 (No. 414); Gros Ventre River, August 22, 1894 (No. 1070).

***Onicus undulatus*, Gray, Proc. Am. Acad. x, 42 (1874). *Carduus undulatus*, Nutt.**

Frequent; Cheyenne, August 11, 1891, B. C. Buffum; Laramie, October 2, 1894 (No. 1156).

***Onicus Virginianus*, Pursh, Fl. ii, 506 (1814). *Carduus Virginianus*, L.**

Very rare; a few specimens from a dry bank, Cummins, July 30, 1895 (No. 1563).

***Oreopis acuminata*, Nutt. Trans. Am. Phil. Soc. vii, 437.**

On dry, sometimes stony ground, in the hills and mountains.

Laramie, July 7, 1894 (No. 356); Union Pass, August 10, 1894 (No. 919).

Orepis elegans, Hook. Fl. i, 297.

A very rare plant; noted but once.

Union Pass, August 12, 1894 (No. 1076).

Orepis glauca, T. & G. Fl. N. A. ii, 488 (1843).

Frequent in wet alkali meadow lands.

Meadow Creek, August 9, 1894 (No. 787); Centennial Valley, August 16, 1895 (No. 1673).

Orepis intermedia, Gray, Syn. Fl. 432 (1884).

Rare; secured by B. C. Buffum on the Wind River, August 2, 1892.

Orepis intermedia gracilis, Gray, Syn. Fl. 432 (1884).

Frequent on dry hillsides in the Laramie range.

Table Mountain, June 30, 1895 (No. 1393).

Orepis runcinata, T. & G. Fl. N. A. ii, 487 (1843).

Infrequent; secured by B. C. Buffum near Big Wind River, August 1, 1892.

Hieracium albidiflorum, Hook. Fl. i, 298.

Abundant on a dry hillside among the fallen timber in a burned-over district.

Centennial Hills, August 16, 1895 (No. 1678).

Hieracium Canadense, Michx. Fl. ii, 86 (1803).

Infrequent; Wolf Creek, August 18, 1892, B. C. Buffum.

Hieracium Fendleri, Schultz, Bip. Bonplandia, ix, 173.

As near as I can judge without other material for comparison, these specimens are nearly typical.

Plentiful on the banks of the Little Laramie River, in the Centennial Valley, August 25, 1895 (No. 1857).

Hieracium gracile, Hook. Fl. i, 298.

Very typical specimens from the Medicine Bow Mountains, where in the alpine region it is found in the greatest profusion. August 23, 1895 (No. 1802).

A very diminutive form was secured on the Teton Mountains; radical leaves only 3-6, stems single, bearing one to four heads. Var. *minimum* would be a suitable designation. August 21, 1894 (No. 1060).

Hieracium Scouleri, Hook. Fl. i, 298.

Very abundant on the Gros Ventre Hills, but not observed east of the Wind River Mountains. August 23, 1894 (No. 963).

Troximon aurantiacum, Hook. Fl. i, 300, t. 104.

Infrequent; Pole Creek, June 29, 1895 (No. 1342).

Troximon aurantiacum purpureum, Gray, Proc. Am. Acad. xix, 72.

Found occasionally in the vicinity of Laramie; Pole Creek, June 30, 1895 (No. 1376); Hutton's Grove, August 9, 1891, B. C. Buffum.

Troximon cuspidatum, Pursh, Fl. Am. Sept. 742 (1814). *Nothocalais cuspidata* (Pursh) Greene.

Somewhat variable; only a few of my numerous specimens typical; possibly some of them should be cut out. Frequent but scattering.

Laramie, August 1893; Wallace Creek, July 29, 1894 (No. 673); from several other places and noted in many localities.

Troximon glaucum, Pursh, Fl. 505 (1814). *Agoseris glauca* (Pursh) Greene.

Frequent in the grassy valleys in the hills and mountains.

Eagle Rock Canon, August 22, 1892, B. C. Buffum; Union Pass, August 10, 1894 (No. 870).

Troximon glaucum dasycepalum, T. & G. Syn. Fl. 432 (1884).

Seemingly nearly alpine and occasionally very abundant.

Union Pass, August 10, 1894 (No. 868); La Plata Mines, August 21, 1895 (No. 1765).

Troximon glaucum laciniatum, Gray, Bot. Cal.

This form I have never been able to locate to my satisfaction, but I am unable to place it under any other name. It is of very frequent occurrence among the sage brush in the Laramie Hills; June 2, 1894 (No. 125); Pole Creek, June 29, 1895 (No. 1376).

Taraxacum officinale, Weber, Prim. Fl. Holst. 56 (1780). *T. Taraxacum*, (L.) Karst.

Apparently the *Dandelion* found its ideal home when it reached Laramie. It occupies every foot of ground along the irrigation ditches of our streets and takes complete possession of the lawns where eternal warfare is not waged upon it. In luxuriant growth and blossom from April to November (No. 80).

Taraxacum officinale alpinum, Koch. Fl. Germ. & Helv. 428 (1837).

Of the several forms of native Dandelions this seems to be the most frequent. Abundant in the high, grassy valleys of the Laramie range.

Pole Creek, June 2, 1894 (No. 109); Centennial Valley, August 17, 1895 (No. 1715).

Taraxacum officinale lividum, (?) Koch.

Some specimens collected by B. C. Buffum, 1892, are doubtfully placed here, and some with nearly entire glaucescent leaves are for the present passed over.

Lactuca leucophæa, Gray, Proc. Am. Acad. xix, 73.

Probably very rare in the state.

Centennial Valley, August 16, 1895 (No. 1674).

Lactuca Ludoviciana, D C. Prodr. vii, 141 (1838).

Rare; possibly confined to the eastern part of the state.

Laramie Peak, August 7, 1895 (No. 1596).

Lactuca pulchella, D C. Prodr. vii, 134 (1838).

Very frequent in the fertile soil of valleys.

Blue Grass Creek, July 13, 1894 (No. 445); Laramie, September 16, 1894 (No. 1146).

Sonchus asper, (L.) All. Fl. Ped. i, 222 (1785).

This has found its way into several parts of the state; Lander, August 3, 1894 (No. 872); Evanston, September 1, 1894, sent by Dr. Solier

Lygodesmia grandiflora, T. & G. Fl. ii, 485.

Very rare; some specimens by B. C. Buffum from near Tie Siding, July 18, 1891.

Lygodesmia juncea, Don. Edinb. Phil. Journ. vi, 311 (1829).

A "weedy" plant very common on the Laramie Plains.

University campus, September 26, 1894 (No. 1165). *Skeleton Weed*.

Stephanomeria minor, Nutt. Trans. Am. Phil. Soc. (II) vii, 427 (1841).

Ptiloria tenuifolia, (Torr.) Raf.

Probably not rare, though observed but twice.

Gros Ventre Hills, August 16, 1894 (No. 925); also a small form of it from Laramie Peak, August 24, 1895 (No. 1624).

Stephanomeria runcinata, Nutt. l. c. 428. *Ptiloria pauciflora*, (Torr.) Raf.

Infrequent; on a ridge of disintegrated rock, Garfield Peak, July 27, 1894 (No. 655).

CAMPANULACEÆ.

Campanula Parryi, Gray, Syn. Fl. Suppl. 395.

Rare; probably confined to the high, grassy valleys of the southern part of the state.

Cummins, July 31, 1894 (No. 1495).

Campanula rotundifolia, L. Sp. Pl. 163 (1753).

One of the very commonest plants in all our hills and mountains, at least where a reasonable amount of moisture is to be found.

Cold Springs, July 14, 1894 (No. 448); Union Pass, August 11, 1894 (No. 814); Cummins, August 1, 1895 (No. 1540). *Blue Bell*.

Specularia perfoliata, A. D. C. Mon. Camp. 351 (1830). *Legousia perfoliata*, (L.) Britton.

Not infrequent in the eastern part of the state.

Whalen Canon, July 18, 1894 (No. 514); Laramie Peak, August 8, 1895 (No. 1657).

ERICACEÆ.

Vaccinum cæspitosum, Michx. Fl. Bor. Am. i, 234 (1803).

Very abundant in the Medicine Bow Mountains and producing the small, sweet berries in profusion.

Centennial Hills, August 18, 1895 (No. 1728). *Blueberry*.

Vaccinum Myrtillus, L. Schk. Handb. t. 107.

In openings in the Spruce timber at high elevations; infrequent.

July 1892, by B. C. Buffum; Centennial Hills, June 9, 1895 (No. 1292).

Arctostaphylos Uva-ursi, (L.) Spreng. Syst. ii, 287 (1825).

Throughout the state, both on open and on wooded hillsides.

Laramie Hills, May 18, 1894 (No. 1214). *Kinnikinick*.

Bryanthus empetriformis, Gray, Proc. Am. Acad. vii, 377.

A beautiful alpine species; in small basin-like heath among the Spruce trees.

Union Peak, August 13, 1894 (No. 1006).

Kalmia glauca, Ait. Hort. Kew. ii, 64 t. 8 (1811).

Rare ; on the margin of a little lake at 9,000 ft., Teton Mountains, August 21, 1894 (No. 952).

Pyrola chlorantha, Sw. Act. Holm. 1810, t. 5 (1810).

In deep, shaded ravines ; Cummins, July 31, 1895 (No. 1505).

Pyrola minor, L. Sp. Pl. 396 (1753).

On the shaded border of a lake immediately at the base of one of the perpetual snow banks of the Medicine Bow Mountains.

La Plata Mines, August 23, 1895 (No. 1825).

Pyrola rotundifolia, L. Sp. Pl. 396 (1753).

Infrequent ; Teton Mountains, August 21, 1894 (No. 947).

Pyrola rotundifolia uliginosa, Gray, Man. Ed. 2, 259 (1856). *P. uliginosa*, Torr.

Much more frequent than the species ; abundant in cold, shaded, wet places in the mountains.

Centennial Hills, August 19, 1895 (No. 1729).

Pyrola secunda, L. Sp. Pl. 396 (1753).

Very abundant in deep woods, especially of high, rich valleys.

Bald Mountain, August 15, 1892 ; Union Pass, August 10, 1894 (No. 802) ; Cummins, July 30, 1895 (No. 1504).

Moneses uniflora, Gray, 273 (1848).

In the densely shaded woods about a mountain lake on the Tetons, August 21, 1894 (No. 945) ; also by B. C. Buffum in a gulch near Bald Mountain, 1892.

Chimaphila umbellata, Nutt. Gen. i, 274 (1818).

On mountain sides in the woods or in the shade of overhanging cliffs.

Teton Mountains, August 21, 1894 (No. 946) ; Laramie Peak, August 6, 1895 (No. 1616).

MONOTROPAEÆ.**Pterospora Andromedea**, Nutt. Gen. i, 269 (1818).

In the pine woods, frequent but not abundant.

Snake River, August 22, 1894 (No. 985) ; Centennial Valley, August 17, 1895 (No. 1681).

Monotropa Hypopitys, L. Sp. Pl. 387 (1753). *Hypopitys Hypopitys*, (L.) Small.

Infrequent ; Centennial Hills, August 17, 1895 (No. 1708).

PRIMULACEÆ.

***Primula farinosa*, L. Sp. Pl. 143 (1753).**

Very rare; not found by the writer, but three fine specimens received from Mr. Houghton, who collected them on the Little Laramie River, June 8, 1894 (No. 187).

***Primula Parryi*, Gray, Am. Journ. Sci. II, xxxiv, 257.**

A very rare plant; collected by B. C. Buffum in the Wind River Mountains, July 21, 1892.

***Androsace filiformis*, Retz. Obs. ii, 10.**

Very abundant in wet, shaded places on mountain streams.

Pole Creek, June 27, 1895 (No. 1318); La Plata Mines, August 23, 1895 (No. 1848).

***Androsace occidentalis*, Pursh, Fl. Am. Sept. 137 (1814),**

Common on dry creek banks, especially in cattle wallows where other vegetation has been killed.

Horse Creek, June 9, 1894 (No. 194); Centennial Valley, June 8, 1895 (No. 1244)

***Androsace septentrionalis*, Lam. Ill. t. 98, f. 2.**

On moist hillsides at both the higher and the lower altitudes.

Union Pass, August 13, 1894 (No. 1030); Table Mountain, June 27, 1895 (No. 1332).

***Androsace septentrionalis subumbellata*, n. var.**

A diminutive alpine form may receive this name. Plant only $\frac{1}{2}$ to 1 inch high; leaves mostly entire; scapes few and one flowered, or, if umbelliferous only three to five; calyx shorter than the corolla, its lobes noticeably shorter than its tube.

On a grassy hillside near the summit of Union Peak, August 13, 1894 (No. 998).

***Dodecatheon Meadia*, L. Sp. Pl. 144 (1753).**

On the partly shaded banks of small brooklets in the Laramie Hills.

Pole Creek, June 27, 1895 (No. 1329).

***Dodecatheon pauciflorum*, Greene.**

The wet meadows in the Laramie River bottoms, in some places, are so densely covered with this plant that at a distance they suggest immense lakes of purplish-blue water. June 19, 1894 (No. 268); Centennial Valley, June 9, 1895 (No. 1312).

Dodecatheon, sp.

Some very small specimens secured by B. C. Buffum at Bald Mountain, with single flowered scapes, probably belong to the var. *alpina*, Gray, of *D. Meadia*. August 8, 1892.

Steironema ciliatum, Baudo, Ann. Sci. Nat. (II) xx, 346 (1843).

Rich soil in thickets on streams.

Laramie Peak, August 7, 1895 (No. 1582); Bald Mountain, August, 1892.

Glaux maritima, L. Sp. Pl. 148 (1753).

On the low, wet shores of alkali ponds and lakes; abundant.

Laramie, June 16, 1894 (No. 248).

OLEACEÆ.**Fraxinus viridis**, Michx. f. Hist. Arb. 3: 115, t. 10 (1813). *F. lanceolata*, Borck.

Rare in the parts of the state collected.

Platte River, July 14, 1894 (No. 480).

APOCYNACEÆ.**Apocynum androsæmifolium**, L. Sp. Pl. 213 (1753).

Frequent on grassy slopes in the foothills of the Platte.

Whalen canon, July 19, 1894 (No. 535); Laramie Peak, August 7, 1895 (No. 1632).

Apocynum cannabinum, L. Sp. Pl. 213 (1753).

Rare in the districts collected, but probably frequent in the north-east.

On the banks of the Platte, July 11, 1894 (No. 396); also on the Big Muddy, July 23, 1894 (No. 596).

ASCLEPIADACEÆ.**Acerates viridiflora linearis**, Gray, Syn. Fl. 2.

Rare; occasional specimens on the banks of the Platte River.

Fairbanks, July 14, 1894 (No. 489).

Asclepias cryptoceras, Watson, King's Rep. (1871).

This is a rare plant, coming into our range only in the western part.

Snake River, May 29, 1892, by Fred McCoullough.

Asclepias Hallii, Gray, Proc. Am. Acad. viii, 69.

Infrequent; on the banks of a clayey ravine at Wood's Landing, July 31, 1895 (No. 1556).

Asclepias speciosa, Torr. Ann. Lyc. N. Y. ii, 218 (1827).

Frequent in the eastern part of the state.

Lusk, July 21, 1894 (No. 575); McGill's Ranch, on the Laramie River, August 3, 1895 (No. 1573).

Asclepias verticillata pumila, Gray, Proc. Am. Acad. xii, 71 (1876).

Rare; in a sandy canon leading to the Platte; Fairbanks, July 14, 1894 (No. 466).

GENTIANACEÆ.

Gentiana affinis, Griseb. Hook. Fl. Bor. Am. i, 56 (1834).

In wet meadows at 8,000 to 10,000 ft.

Upper Wind River, August 8, 1894 (No. 754); Snake River, August 22, 1894 (No. 960); La Plata Mines, August 22, 1895 (No. 1853).

Gentiana Amarella acuta, Hook. *G. acuta*, Michx.

In meadow lands on the Laramie River and its tributaries; very abundant.

Cummins, July 30, 1895 (No. 1543); Centennial Valley, August 25, 1895 (No. 1852).

Gentiana Amarella stricta, Watson, King's Rep. (1871).

Rare; specimens from Wolf Creek, August, 1892, by B. C. Buffum.

Gentiana calycosa, Griseb. in Hook. Fl. Bor. Am. ii, 68 (1838).

This beautiful alpine species probably in all of our higher mountains.

Tetons, August 21, 1894 (No. 1057); La Plata mines, August 22, 1895 (No. 1767).

Gentiana frigida, Hænke. Jacq. Coll. ii, 13.

As rare as it is odd; on the shore of a small alpine lake, La Plata Mines, August 23, 1895 (No. 1804).

Gentiana humilis, Stev. Act. Mosq. iii, 258.

Frequent on the banks of small creeks in the hills and mountains. Horse Creek, June 9, 1894 (No. 220); Centennial Valley, June 9, 1895 (No. 1313).

Gentiana Oregana, Engelm. Gray, Syn. Fl. ii, pt. i, 122 (1886).

Infrequent; in a mountain valley, at 8,000 ft.; Cummins, July, 29, 1895 (No. 1527).

Gentiana Parryi, Engelm. Trans. St. Louis Acad. ii, 218, t. 10.

Wet, subalpine valleys.

Cummins, July 29, 1895 (No. 1526); Bald Mountain, August 17, 1892.

Gentiana serrata holopetala, Gray, Bot. Cal. i, 481 (1876).

Under this name I have two quite distinct forms, neither of which is typical, but lacking salient characters enough to separate them. The one is small and simple stemmed, the other freely branched from the base. Both with unusually large showy flowers conspicuously fringed. Remarkably abundant in high, wet valleys.

Union Pass, August 10, 1894 (No. 865); Cummins, July 30, 1895 (No. 1539); Centennial Valley, August 17, 1895 (No. 1725); La Plata, August 21, 1895 (No. 1766).

Gentiana tenella, Rottb. Act. Haffn. x, 436, t. 2.

Rare; Cummins, July 27, 1895 (No. 1518).

Pleurogyne rotata, Griseb. Gent. 309 (1839).

Very rare; on the hummocks in a swampy meadow, Centennial Valley, August 18, 1895 (No. 1701).

Swertia perennis, L. Sp. Pl. i, 226 (1753).

In subalpine meadow swamps; frequent.

Union Pass, August 13, 1894 (No. 988); Centennial Hills, August 20, 1895 (No. 1742).

Frasera speciosa, Dougl. Hook. Fl. Bor. Am. ii, 66 (1838).

By reason of its size, a conspicuous and characteristic object both on the timbered and denuded mountain slopes.

Wind River Mountains, August 12, 1894 (No. 935); Laramie Peak, August 6, 1895 (No. 1609).

POLEMONIACEÆ.***Phlox bryoides***, Nutt. Journ. Acad. Phila. II. i, 153 (1848).

This is very abundant on rather naked limestone ridges where they crop out on the Laramie Plains and in the foothills. May 25, 1894 (No. 67); June 7, 1895 (No. 1280).

Phlox caespitosa, Nutt. Journ. Acad. Phila. vii, 41 (1834).

One of the earliest flowers on the plains; very abundant; pink flowered forms are common.

Laramie, May 12, 1894 (No. 8), and at various other times.

Phlox Douglasii, Hook. Fl. Bor. Am. 2: 73, t. 158 (1834).

On the sides of dry, sandy ravines and ridges; infrequent.

Uva, July 10, 1894 (No. 397); also from Beaver Divide, July, 1891.

Phlox longifolia, Nutt. Journ. Acad. Phila. vii, 41 (1834).

Leaves mostly less than an inch in length, otherwise the plant seems typical; very abundant in the Laramie Hills; June 7, 1894 (No. 182), and at several other times.

Phlox longifolia brevifolia, Gray.

Specimens perfectly in accord with description in Syn. Fl. were obtained at La Plata Mines, August 24, 1894 (No. 1827).

Phlox nana, Nutt. Pl. Gamb. 153.

If this determination is right, which it is if the descriptions go for anything, this extends the range of this plant quite a little.

Collected on Snake River, May 29, 1892, by Fred McCoullough.

Gilia aggregata, Spreng. Syst. i, 626 (1825).

Widely distributed, but never in any great abundance; Beaver Creek, July 17, 1892; Bell Springs, July 4, 1891; Snake River, August 22, 1894 (No. 961).

Gilia aggregata attenuata, Gray, Syn. Fl. II, i, 145 (1886).

On an abrupt, stony, gravelly bank of the Laramie River. Cummins, July 29, 1895 (No. 1522).

Gilia Breweri, Gray, Proc. Am. Acad. viii, 266.

Infrequent; possibly confined to the Pacific slope.

Gros Ventre River, August 18, 1894 (No. 1094).

Gilia gracilis, Hook. Bot. Mag. t, 2924 (1829).

Very abundant on the rich sandy loam of the small valleys of the Laramie Hills and in similar locations throughout the state.

Pole Creek, June 2, 1894 (No. 107); Inyan Kara Divide, August 30, 1892.

Gilia inconspicua, Sweet, Hort. Brit. 286 (1826).

Thus far only from the Big Wind River, August 3, 1892, by B. C. Buffum; August 5, 1894 (No. 709).

Gilia inconspicua sinuata, Gray, Proc. Am. Acad. viii, 278.

This extends the range of this plant northward somewhat ; in the sandy bed of a dry creek ; Muskrat July 30, 1894 (No. 683).

Gilia linearis, Gray, Proc. Am. Acad. xvii, 223 (1882). *Collomia linearis*, Nutt.

This is by far the most frequent of our Gilias, common in the rich loam along streams everywhere.

Pole Creek, June 2, 1894 (No. 108); Sybille Creek, July 8, 1894 (No. 401).

Gilia minima, Gray, Proc. Am. Acad. viii, 269 (1880). *Navarretia minima*, Nutt.

Not found on the Atlantic slope.

Silver Creek, August 26, 1894 (No. 1129).

Gilia nudicaulis, Gray, Proc. Am. Acad. viii, 266 (1870).

The type locality is in the western part of this state, and the plant is probably common throughout the state, but so small and inconspicuous as usually to be passed over.

Horse Creek, June 9, 1894 (No. 193).

Gilia Nuttallii, Gray, Proc. Am. Acad. viii, 267 (1870).

An undoubted specimen of this species without data, by B. C. Buffum, in 1892. Probably near Bald Mountain, August, 1892.

Gilia spicata, Nutt. Journ. Acad. Phil. (II) i, 156 (1848).

Frequent about the sand dunes in the foothills.

Pass Creek, June 20, 1892; Laramie Hills, June 7, 1894 (No. 175). My number 259 approaches *G. spicata capitata*, Gray, pretty closely, but I do not think it typical.

Polemonium confertum, Gray, Proc. Acad. Phila. 1863, 63 (1863).

A beautiful alpine plant on grassy or rocky slopes.

Union Peak, August 13, 1894 (No. 991); La Plata Mines, August 22, 1895 (No. 1823).

Polemonium confertum mellitum, Gray, l. c.

In crevices and on ledges on the higher rocky summits of the Laramie Mountains.

Richardson's Peak, June 9, 1894 (No. 208); Laramie Peak, August 7, 1895 (No. 1625).

Polemonium humile pulchellum, Gray, Syn. Fl. II. i, 150 (1886).

What seems to belong here was secured by B. C. Buffum in 1892; no other data.

Polemonium occidentale, Greene. *Pittonia* ii, 75 (1890).

Name communicated by Prof. Greene. Rare; in spring bog on Muddy Creek, August 25, 1894 (No. 1104).

HYDROPHYLLACEÆ.

Hydrophyllum occidentale, Gray, *Proc. Am. Acad.* x, 314.

This, I am sorry to say, I have distributed as *H. Virginicum*,—a piece of carelessness, for the specimens plainly enough belong here.

Very abundant in the copses on our streams.

Pole Creek, June 2, 1894 (No. 89); Table Mountain, June 29, 1895 (No. 1408).

Ellisia Nyctelea, L. *Sp. Pl. Ed. 2*, 1662 (1763). *Macrocalyx Nyctelea*, Kuntze.

On dry loam soil on creek banks; observed only on the east slopes of the Laramie range.

Table Mountain, June 27, 1895 (No. 1350).

Phacelia circinata, Jacq. *Eclog.* 135 t. 91.

Of the synonymy and citations applicable to my specimens, I am in doubt, but all answer to the above in *Syn. Fl. II. i*, 159.

Inyan Kara Divide, August 30, 1892; Union Peak, August 14, 1894 (No. 1082); Pole Creek, June 26, 1895 (No. 1323).

Phacelia Franklinii, Gray, *Man. Ed. 2*, 329 (1856).

This gives one more locality for the range of this plant.

Bacon Creek, August 15, 1894 (No. 914).

Phacelia glandulosa, Nutt. *Fl. Gamb.* 160.

Infrequent and scattering; Pole Creek, June 30, 1895 (No. 1361); also noted at Cummins.

Phacelia Menziesii, Torr. Watson, *King Rep.* 252.

These handsome specimens were sent to us from Snake River, May 29, 1892, Fred McCoullough.

Phacelia sericea, Gray, *Am. Journ. Sci. ser. 2*, (1862) xxxiv, 254.

Very common in moist, partly shaded ground in the hills and along streams.

Pole Creek, June 2, 1894 (No. 102); a white flowered form from the Centennial Valley, June 9, 1895 (No. 1283).

Phacelia sp.

A small annual having affinities with both *P. circinata*, and *P. Franklinii*, must for the present be passed over.

Sybillie, July 8, 1894 (No. 318).

BORAGINACEÆ.**Coldenia Nuttallii**, Hook. Kew. Journ. Bot. iii, 296 (1851).

In a sandy canon or valley leading to the Big Wind River, August 6, 1894 (No. 719); observed in no other locality.

Echinospermum floribundum, Lehm in. Hook. Fl. 2: 84, t. 164 (1834). *Lapula floribunda*, Greene.

Growing almost at the water's edge on some of the streams in the eastern part of the state.

Sybillie Creek, July 7, 1894 (No. 348); Pole Creek, June 29, 1895 (No. 1367):

Echinospermum Lapula, Lehm. Asperif. 121 (1818). *Lapula Lapula*, (L.) Karst.

This weed seems to have found its way into waste places about town.

Laramie, June 17, 1891; also at Uva, July 10, 1894 (No. 424).

Echinospermum Redowskii occidentale, Watson, King's Exp. 246 (1871). *Lapula Texana*, (Scheele) Britton.

Common everywhere; Laramie, June 28, 1894 (No. 294); Blue Grass Hills, July 8, 1894 (No. 305).

Echinospermum Redowskii cupulatum, Gray, in Brew. & Wats. Bot. Cal. i, 530 (1876).

This, I note, has been reduced to the same as the preceding, but to say the least there is a marked difference between the nutlets.

By B. C. Buffum, in the northeastern part of the state, August 19, 1892.

Allocarya Nelsonii, Greene, Erythea iii, 48 (1895).

The original description is as follows: "Annual, diffuse, the stoutish and somewhat succulent branches strigose-pubescent, six inches long, rather densely racemose throughout and with a short bract subtending each pedicel; nutlets $\frac{3}{4}$ line long, ovate-lanceolate, carinate ventrally almost down to the nearly basal rounded or obscurely trigonous scar, the back with rather few and sharp

transverse ridges beset with tufts of uncinat-tipped bristles, the intervals with low, muriculate-roughened tuberculations."

Only one small patch of these plants observed; they had taken possession of a few depressions, possibly old buffalo wallows, on bottom land near Silver Creek, August 28, 1894 (No. 1198).

Allocarya scopulorum, Greene, Pitt. i, 16 (1887).

Rather infrequent; Upper Wind River, August 10, 1894 (No. 768); Centennial Valley, August 25, 1895 (No. 1850).

Krynitzkia Californica subglochidiata, Gray, Bot. Cal. i, 526.

Common on dry loam soil near streams.

Cooper Creek, June 19, 1892; Table Mountain June 28, 1895 (No. 1311).

Krynitzkia crassisepala, Gray, Proc. Am. Acad. xx, 268 (1885).

Cryptlanthe crassisepala, (T. & G.) Greene.

Frequent on sandy plains.

Laramie, August 8, 1891; Blue Grass Creek, July 8, 1894 (No. 304).

Krynitzkia Fendleri, Gray, l. c. *Cryptlanthe Fendleri*, (Gray) Greene.

Infrequent; Cummins, July 25, 1895 (No. 1523).

Krynitzkia fulvocanescens, Gray, Proc. Am. Acad. xx, 280 (1885).

Oreocarya fulvocanescens, (Gray) Greene.

Fine specimens of this were secured by Prof. Buffum, at Cooper Creek, June 18, 1892.

Krynitzkia glomerata, Gray, Proc. Am. Acad. xx, 279 (1885). *Oreocarya glomerata*, (Gray) Greene.

This is perhaps our commonest *Krynitzkia*; frequent on dry hill-sides, railroad embankments and on the plains.

Laramie, July 8, 1894 (No. 418); Table mountain, June 30, 1895 (No. 1362); a very large, coarse form from Uva, July 10, 1894 (No. 388).

Krynitzkia glomeriflora, Greene.

Frequent in dry, rich loam soil along streams.

Pole Creek, near Table Mountain, June 2, 1894 (No. 152); Centennial Valley, June 9, 1895 (No. 1335).

Krynitzkia Jamesii, Gray, Proc. Am. Acad. xx, 277. *Oreocarya suffruticosa*, Greene.

Infrequent; in canons near the Platte River, July 14, 1894 (No. 477).

Krynitzkia Pattersoni, Gray, Proc. Am. Acad. xx, 278.

Rare; in the Laramie Hills, July 7, 1894 (No. 412).

Krynitzkia sericea, Gray, Proc. Am. Acad. xx, 277. *Oreocarya sericea*, Greene.

Frequent on rocky slopes in the Laramie Hills; June 16, 1894 (No. 255); Uva, July 10, 1894 (No. 389).

Krynitzkia virgata, Proc. Am. Acad. xx, 279.

Frequent on sandy ridges in the foothills.

Telephone canon, June 15, 1894 (No. 231); Centennial Valley, June 9, 1895 (No. 1267).

Krynitzkia Watsoni (?) Gray, Proc. Am. Acad. xx, 270.

These are somewhat doubtfully placed here; collected on wet, shaded rocky ledges in the Centennial Hills, August 17, 1895 (No. 1684).

Mertensia alpina, Don. Syst. iv, 320.

Strictly alpine from a climatic point of view, but hardly so from that of altitude; very early in the Laramie Hills while freezing nights are still the rule; often in blossom by April 20. (Nos. 33 and 1222).

Mertensia lanceolata, DC. Prodr. x, 88 (1846).

• Very variable as to size and general appearance, but floral characters and the light-green glaucous color constant. It is abundant and frequent in our foothills in two forms: a small form from large, coarse rootstocks, very early, radical leaves few, stem leaves nearly uniform, panicle close and leafy; a much larger form later in the season, usually in copses, stem leaves gradually reduced in size, panicle long and open. 1, Laramie Hills, May 16, 1894 (No. 34); 2, Pole Creek, June 28, 1895 (No. 1234).

Mertensia lanceolata viridis, n. var.

Root stocks slender, creeping in the crevices among the rocks; radical leaves numerous, long and slender petioled, from oblong to elliptical; cauline leaves oblong, gradually reduced in size; stems few and slender, 5-8 inches high, bearing an open panicle; floral characters those of the species, except that the corolla tube is wider and shorter. *Mertensia lanceolata*, DC.

This plant is alpine in habitat and may be known by the bright green color of its leaves, which are scarcely scabro-puberulent under a lens.

On rocky ledges near the summit of Laramie Peak, August 7, 1895 (No. 1608).

Mertensia sibirica, Don. Syst. iv, 320.

Quite a large series of specimens from many localities and different altitudes, and of very different general appearance, have all been reduced to this. Environment produces greater differences than is usually conceded. Wet places, along streams and in the mountains; Sybille, July 8, 1894 (No. 408); Garfield Peak, July 29, 1894 (No. 689); Union Pass, August 13, 1894 (No. 1031) and other localities.

Myosotis sylvatica alpestris, Koch.

This beautiful little plant is found in abundance in the alpine regions of our northern mountains. Little Bald Mountain, August 15, 1892 B. C. Buffum; Union Pass, August 11, 1894 (No. 838).

Onosmodium molle, Michx. Fl. Bor. Am. I: 133, t. 15 (1803).

Rare and probably confined to the eastern part of the state. Orin Junction, August 1892; Platte River, July 14, 1894 (No. 506).

Lithospermum angustifolium, Michx. Fl. Bor. Am. i, 130 (1803).

Very common on the plains and in the mountain valleys. University Campus, June 4, 1894 (No. 174); in its fruiting form July 23, 1895 (No. 1428).

Lithospermum pilosum, Nutt. Journ Acad. Phil. vii, 43 (1834).

Much less frequent than the preceding; Middle Pass, June 20, 1892; Gros Ventre River, August 18, 1894 (No. 1090).

CONVOLVULACEÆ.

Ipomea leptophylla, Torr. in Frem. Rep. 95 (1845).

Abundant in the eastern part of the state on the Platte and in the adjacent foothills

Fort Laramie, September 3, 1892; Fairbanks, July 14, 1894 (No. 491).

Convolvulus sepium, L. Sp. Pl. 153 (1753).

Collected by B. C. Buffum, August 1, 1891, probably at Cheyenne. Rare in the state.

Evolvulus argenteus, Pursh Fl. Am. Sept. 187 (1814). *E. Nuttallianus*, R. & S.

Infrequent; dry plains near Uva, July 10, 1894 (No. 398); also at Sheridan, September, 1895.

Ouscuta decora, Engelm. Trans. St. Louis Acad. i, 501 (1859). *C. indecora*, Choisy.

Parasitic on *Alfalfa*, Sheridan Experiment Farm, August 19, 1892.

Ouscuta epilinum, Weihe. Archiv. Apoth. viii. 54 (1824).

On *Alfalfa*, Laramie Experiment Farm, July, 1894 (No. 1210).

SOLANACEÆ.

Solanum rostratum, Dunal. Sol. 234, t. 24 (1813).

Probably abundant on the eastern border.

Fort Laramie, September 5, 1892; Whalen Canon, July 18, 1894 (No. 527). Not yet reported as a bad weed in any locality.

Solanum triflorum, Nutt. Gen. i, 128 (1818).

Particularly annoying as a weed in garden and "truck" patches; small plants, such as *Carrots* and *Parsnips*, must be "weeded" by hand or this weed will completely smother them.

Experiment Farm, September 15, 1894.

Physalis lanceolata, Michx. Fl. Bor. Am. i, 149 (1803).

This genus seems to be confined to the lower altitudes of the north and east; rather plentiful on the Platte and adjoining foothills.

A large form of this species from Blue Grass Hills, August 8, 1894 (No. 365); also a small and more pubescent form from the same place (No. 295).

Physalis lanceolata lævigata, Gray, Proc. Am. Acad. x, 62.

Infrequent; in a canon near the Platte at Fairbanks, July 14, 1894 (No. 478).

SCROPHULARIACEÆ.

Scrophularia Marylandica, L. Sp. Pl. 619 (1753).

Our specimens are far from typical; the thyrsus very narrow, the separate cymes simple; leaves large and truncate at base.

Sybilie, July 8, 1894 (No. 317); Pole Creek, June 30, 1895 (No. 1410). Specimens from Garfield Peak, July 29, 1894 (No. 690) have large deltoid-cordate leaves even to the summit of the stem; inflorescence only a simple cyme.

Pentstemon acuminatus, Dougl. Lindl. Bot. Reg. t. 1285 (1829).

Abundant in the Laramie range in the foothills, on stony slopes. Laramie Hills, June 7, 1894 (No. 180); Table Mountain, June 28, 1895 (No. 1325).

Pentstemon cæruleus, Nutt. Gen. ii, 52 (1818).

Frequent on the Laramie Plains, especially on sandy ridges bordering on the Laramie River; June 7, 1894 (No. 179); June 18, 1895 (No. 1308).

Pentstemon cæspitosus, Nutt. Gray, Proc. Am. Acad. vi, 66.

A few good specimens of this rather rare plant from Wheatland, June 11, 1892, by B. C. Buffum.

Pentstemon confertus cæruleo-purpureus, Gray, Proc. Am. Acad. vi, 72.

Frequent on subalpine grassy slopes, and much reduced specimens from alpine locations.

Saratoga July 17, 1892; Union Pass, August 11, 1894 (No. 833); Union Peak, August 13, 1894 (No. 1017).

Pentstemon cristatus, Nutt. Gen. ii, 52 (1818).

Common in sandy ravines in the foothills of the Laramie range and probably elsewhere.

Telephone Canon, June 15, 1894 (No. 235); Pole Creek, June 28, 1895 (No. 1346).

Pentstemon glaber, Pursh, Fl. Am. Sept. 738 (1814).

Infrequent and usually only scattering plants.

Sybillie, July 8, 1894 (No. 327); Cottonwood Canon, August 4, 1895 (No. 1566).

Pentstemon glaber Utahensis, Watson, Bot. King Surv. 217 (1871).

Slightly variant, but I believe true specimens of this were obtained in three localities: Gros Ventre River, August 18, 1894 (No. 1093); Cummins, July 30, 1895 (No. 1541); Cottonwood Canon, August 4, 1895 (No. 1579).

Pentstemon glaucus, Graham, Edinb. Phil. Journ. 1829, 348.

Herbarium specimens fail to do justice to this singularly beautiful plant, as shape and color are both largely lost. It occurs in the alpine region of all our ranges.

Tetons, August 21, 1894 (No. 1001); Laramie Peak, August 7, 1895 (No. 1619); La Plata Mines, August 22, 1895 (No. 1792).

***Pentstemon humilis*, Nutt.**

Exceedingly abundant in the Laramie range at the foot of rocky ledges and in stony ravines.

Pole Creek, June 2, 1894 (No. 131); Table Mountain, June 27, 1895 (No. 1322).

***Pentstemon laricifolius*, Hook. & Arn. Bot. Beechy. 376.**

Abundant on stony ridges on the Laramie Plains and their foothills. July 7, 1894 (No. 419); July 27, 1895 (No. 1442).

***Pentstemon secundiflorus*, Benth. DC. Prodr. x, 324.**

Infrequent; specimens by Mr. Hartley from near Sherman, July 9, 1891.

***Pentstemon strictus*, Benth. DC. Prodr. x, 324.**

In stony ravines in the hills; Sybille, July 8, 1894 (No. 402); Cummins, July 28, 1895 (No. 1472).

***Collinsia parviflora*, Lindl. Bot. Reg. t. 1082 (1827).**

Very abundant in sandy loam soil on creek banks. .

Pole Creek, June 2, 1894 (No. 46); Centennial Valley, July 17, 1895 (No. 1685).

***Mimulus alsinoides*, Benth. DC. Prodr. x, 351.**

Centennial Hills, August 17, 1895 (No. 1683).

***Mimulus floribundus*, Lindl. Bot. Reg. xiv, t. 1125 (1828).**

Infrequent: good, but diminutive; from a wet ravine near Cummins, July 28, 1895 (No. 1515).

***Mimulus glabratus Jamesii*, Gray, Syn. Fl. Suppl. 447.**

Infrequent; Whalen Canon, July 19, 1894 (No. 543).

***Mimulus Langsdorffii Tilingi*, Greene, Journ. Bot. for Jan., 1895.**

Our commonest *Mimulus*; springy places in the hills and mountains.

Garfield Peak, July 29, 1894 (No. 688); Centennial Valley, August 16, 1895 (No. 1670).

***Mimulus Lewisii*, Pursh, Fl. ii, 427 (1814).**

On stony, wet ground near creeks; infrequent,

Teton Mountains, August 21, 1894 (No. 942); Centennial Valley, August 16, 1895 (No. 1672).

***Mimulus rubellus*, Gray, Bot. Mex. Bound. 116.**

Rare, or at least rarely observed; our plants small and inconspicuous.

On a naked, gravelly hillside, Centennial, June 9, 1895 (No. 1287).

Synthyris plantaginea, Benth. DC. Prodr. x, 455 (1846).

Some specimens from the Teton Mountains are doubtfully placed here. August 21, 1894 (No. 986).

Synthyris rubra, Benth. l. c. *Wulfenia rubra*, (Hook.) Greene.

Of very frequent occurrence in sage brush valleys; variable as to foliage.

Telephone Canon, May 12, 1894 (No. 29); Laramie Hills, June 5, 1895, (No. 1242).

Veronica alpina, L. Sp. Pl. 11 (1753).

Frequent in subalpine stations; wet, grassy slopes.

Bald Mountain, August 15, 1892; Union Pass, August 11, 1894 (No. 831); Centennial Hills, August 19, 1895 (No. 1740).

Veronica Americana, Schwein. Benth. in DC. Prodr. x, 468 (1846).

In all streams and springs.

Sybilie Creek, July 8, 1894 (No. 403); noted in many other localities.

Veronica peregrina, L. Sp. Pl. 14 (1753).

In boggy places; Lander, August 3, 1894 (No. 698); Centennial Valley, August 25, 1895 (No. 1854).

Veronica serpyllifolia, L. Sp. Pl. 12 (1753).

On the grassy banks of our little mountain brooks; frequent.

Horse Creek, June 9, 1894 (No. 192).

Castilleja flava, Watson, Bot. King Surv. 230 (1871).

Of rather frequent occurrence at 7,000-8,000 ft. in the hills.

Laramie Hills, July 7, 1894 (No. 352); Table Mountain, June 27, 1895 (No. 1338).

Castilleja linariæfolia, Benth. DC. Prodr. x, 520.

Hardly subalpine; frequent on sandy, grassy slopes.

Laramie Hills, July 7, 1894 (No. 352); Laramie Peak, August 6, 1895 (No. 1570).

Castilleja miniata, Dougl. Hook. Fl. ii, 106.

I have placed here a number of specimens, some of which rather doubtfully. Most of them were secured on wet stream banks and I think the following numbers, at least, are right. Lander, August 4, 1894 (No. 742); Union Pass, August 11, 1894 (No. 835).

Castilleja minor, Gray, Bot. Cal. i, 573 (1876).

Rare; observed but once. Fort Washakie, August 5, 1894 (No. 744).

Castilleja pallida, Kunth. Syn. Pl. Æquin. ii, 100.

On the shaded banks of mountain streams, at 8,000 ft. and upward.

Cummins, July 28, 1895 (No. 1461); observed at a number of other localities.

Castilleja pallida occidentalis, Gray, Bot. Cal. i, 573 (1876).

Some specimens from Union Peak I am unable to place elsewhere; August 13, 1894 (No. 1011).

Castilleja pallida septentrionalis, Gray, l. c.

Undoubted specimens of this were observed in a number of alpine and subalpine stations. This prefers the wet banks of wooded streams or the shores of alpine lakes.

Centennial Hills, August 18, 1895 (No. 1726); La Plata Mines, August 23, 1895 (No. 1808).

Castilleja parviflora, Bong. Veg. Sitch. 158 (1831).

Most frequent and earliest; in sandy loam soil among the sage brush.

Pole Creek, June 2, 1894 (No. 120); Centennial Valley, June 9, 1895 (No. 1291).

Orthocarpus luteus, Nutt. Gen. ii, 56 (1818).

Frequent in wet, sandy soil, especially along streams.

Whalen Canon, July 16, 1894 (No. 534); Lander, August 3, 1894 (No. 741); Cummins, July 30, 1895 (No. 1537).

Orthocarpus pallescens, Gray, Am. Journ. Sci. ser. 2, xxxiv, 339.

From type locality, probably not far from the place where Parry collected it.

Gros Ventre River, August 15, 1894 (No. 900).

Orthocarpus pilosus, Watson, Bot. King Surv. 231 (1871).

This rare plant, determined for me by Dr. Rose, was collected by B. C. Buffum, on Three Mile Creek, June 20, 1892.

Cordylanthus ramosus, Nutt. Gen. ii, 57 (?).

Very abundant on the alkali-clay hills adjacent to the Wind River; at Dubois, August 10, 1894 (No. 711).

***Pedicularis bracteosa*, Benth. Hook. Fl. ii, 110 (1838).**

Probably confined to our northwest areas.

Union Pass, August 11, 1894 (No. 834).

***Pedicularis crenulata*, Benth. DC. Prodr. x, 568.**

Abundant; growing in clumps in high meadow lands.

Laramie, June 19, 1892; Cummins, July 30, 1895 (No. 1528).

***Pedicularis Groenlandica*, Retz. Fl. Scand. Ed. 2, 145 (1795).**

Frequent and abundant on subalpine mountain streams.

Warm Spring Creek, August 19, 1894 (No. 806); Centennial Hills, August 19, 1895 (No. 1739).

***Pedicularis Parryi*, Am. Journ. Sci. ser. 2, xxxiii, 250.**

Probably rare; a few specimens only, from Union Peak, August 13, 1894 (No. 1033).

***Pedicularis procera*, Gray, Am. Journ. Sci. ser. 2, xxxiv, 251.**

Rare; in a wooded canon leading to the Laramie River, at Cummins, July 30, 1895 (No. 1550).

***Pedicularis racemosa*, Dougl. Hook. Fl. ii, 108 (1838).**

This comes as near as any to marking a zonal belt; encountered at about 9,000 ft. in all our mountain ranges visited, and found up to timber line.

Bald Mountain, August 17, 1892; Union Pass, August 11, 1894 (No. 830); noted at Laramie Peak and in the Medicine Bow Mountains.

OROBANCHACEÆ.

***Aphyllon fasciculatum*, Gray, Syn. Fl. 2; Part 1, 312 (1878). *Thalesia fasciculata*, Britton.**

Frequent and occasionally abundant.

Pine Creek, July 18, 1892; Pole Creek, July 1, 1895 (No. 1360), hosts,—*Artemisia frigida* and *A. Canadensis*.

***Aphyllon uniflorum*, T. & G. Gray, Man. 290 (1848).**

Rare; Gros Ventre River, August 22, 1894 (No. 1071), host not noted.

VERBENACEÆ.

***Lippia cuneifolia*, Steud. Torr., in Marcy's Rep. 293, t. 17 (1853).**

Laramie River bottom lands near Uva; not observed elsewhere. July 10, 1894 (No. 387).

Verbena bracteosa, Michx. Fl. Bor. Am. ii, 13 (1803).

This is a weedy plant, thriving equally well in cultivated and uncultivated grounds.

Blue Grass Hills, July 8, 1894 (No. 320); Laramie Peak, August 8, 1895 (No. 1652).

Verbena stricta, Vent. Hort. Cels, t. 53 (1800).

Probably frequent in the lower altitudes of the northeast; not observed except in the Platte Valley, near Fairbanks, July 14, 1894 (No. 505). A form with several large spikes was obtained in Whalen Canon, July 18, 1894 (No. 538).

LABIATÆ.**Mentha Canadensis**, L. Sp. Pl. 576 (1753).

Frequent on all water courses and about springs.

Whalen Canon, July 18, 1894 (No. 546); specimens from a large number of other localities.

Lycopus lucidus, Turcz. Benth. in DC. Prodr. xii, 178 (1848).

Infrequent; Popo Agie River, August 2, 1894 (No. 735).

Lycopus sinuatus, Ell. Bot. S. C. and Ga. i, 126 (1816).

Wet grounds about springs and ponds; frequent.

Laramie, July, 1891; Whalen Canon, July 19, 1894 (No. 542).

Hedeoma Drummondii, Benth. Lab. Gen. and Sp. 368 (1834).

Occasional in dry loam soil.

Whalen Canon, July 19, 1894 (No. 548).

Hedeoma Reverchoni, Gray, Syn. Fl. 363.

Rare; its collection in this state extends the range of this plant northward very much; good specimens from Pole Creek, June 30, 1895 (No. 1374).

Salvia lanceolata, Willd. Enum. 37 (1809).

Only occasionally on rather dry hillsides and plains.

Blue Grass Hills, July 9, 1894 (No. 374); Centennial Valley, August 20, 1895 (No. 1395).

Monarda fistulosa, L. S. Pl. 22 (1753).

Probably confined to the eastern portion of the state; thus far noted only in the region east of Laramie Peak.

Fairbanks, July 14, 1894 (No. 508); Cottonwood Canon, August 4, 1895 (No. 1577).

Lophanthus urticifolius, Benth. Bot. Reg. xv, sub. t. 1282 (1829).
Vleckia urticifolia, (Benth.) Holzinger.
Very rare; possibly only in the northwest.
Snake River, August 22, 1894 (No. 984)

Dracocephalum parviflorum, Nutt. Gen. ii, 35 (1818).
Principally in abandoned fields.
Sybille Creek, July 8, 1894 (No. 326); Laramie Peak, August 8, 1895 (No. 1648).

Scutellaria galericulata, L. Sp. Pl. ii, 599 (1753).
Not infrequent in wet places.
Fairbanks, July 13, 1894 (No. 470); Centennial Valley, August 20, 1895 (No. 1760).

Scutellaria resinosa, Torr. Ann. Lyc. N. Y. ii, 232 (1827).
On abrupt banks along streams, but in comparatively dry ground.
Pole Creek, June 2, 1894 (No. 94); June 29, 1895 (No. 1365).

Brunella vulgaris, L. Sp. Pl. 600 (1753).
Very infrequent in the parts of the state collected
Specimens from Wolf Creek, August 18, 1892, B. C. Buffum.

Physostegia parviflora, Nutt. Benth. in DC. Prodr. 12, 434 (1848).
On the borders of lakes and ponds, growing even in the edge of the water.
Bull Lake, August 8, 1894 (No. 732); Laramie River, near Ione Ranch, August 10, 1895 (No. 1666).

Stachys palustris, L. Sp. Pl. 580 (1753).
Frequent on sandy creek banks which are covered with under-shrubs and weedy plants.
Wind River, August 8, 1894 (No. 857); Cummins, July 28, 1895 (No. 1484); noted in many other places.

PLANTAGINACEÆ.

Plantago eriopoda, Torr. Ann. Lyc. N. Y. ii, 237 (1827).
Common on wet alkali flats about Laramie and in similiar locations elsewhere; June 1, 1894 (No. 42). *Plantain*.

Plantago lanceolata, L. Sp. Pl. 113 (1753).
A recently introduced weed on the Lander Experiment Farm; September, 1895, by J. S. Meyer.

Plantago major, L. Sp. Pl. 112 (1753).

Received from Sheridan as one of the weeds upon the Experiment Farm, September, 1895, by J. F. Lewis.

Some specimens from Wolf Creek, apparently native there, collected August 8, 1892, by B. C. Buffum, are doubtfully placed here. Spike very slender and leaves almost acute.

Plantago Patagonica gnaphalioides, Gray, Man. Ed. 2, 269 (1856).

Plantago Purshii, R. & S.

Frequent on dry, gravelly hillsides in the Laramie range. Observed only in the eastern part of the state.

Laramie, August, 1891; Wheatland, July, 1891; Table Mountain, June 28, 1895 (No. 1356).

Plantago Tweedyi, Gray, Syn. Fl. II, Part i, 390 (1886).

Three specimens only of this very rare plant were secured on a grassy hillside near the La Plata Mines, August 21, 1895 (No. 1798).

I am not aware that any other specimens have been collected since it was originally collected on the Yellowstone River by Mr. Frank Tweedy.

Oxybaphus angustifolius, Sweet. Hort. Brit. 429 (1830). *Allionia linearis*, Pursh.

Never abundant, only scattering specimens, often in cultivated ground.

Wheatland, July 9, 1894 (No. 379); Cottonwood Canon, August 4, 1895 (No. 1560); also from Sheridan, September, 1895.

Oxybaphus hirsutus, Choisy in DC. Prodr. xiii, part 2, 433 (1849). *Allionia hirsuta*, Pursh.

Rare; noted but once; Whalen Canon, July 18, 1894 (No. 515).

Oxybaphus nyctagineus, Sweet. Hort. Brit. 429 (1830). *Allionia nyctaginea*, Michx.

Very rare, unless it be in the northeastern part of the state.

Fairbanks, July 14, 1894 (No. 469).

Abronia fragrans, Nutt. Hook. Kew. Journ. Bot. v, 261 (1853).

Frequent on the sandy plains of the eastern part of the state.

Inyan Kara Divide, August 29, 1892; Platte River, July 14, 1894 (No. 464); Cummins, July 28, 1895 (No. 1473).

***Abronia micrantha*, Torr.**

Very rare; on the plains and hillsides; by children called the *Sand Flower*.

Near Willow Creek, July 22, 1894 (No. 630).

ILLECEBRACEÆ.

***Paronychia Jamesii*, T. & G. Fl. N. A. i, 170 (1838).**

Frequent on dry, open slopes in the Laramie range.

Fairbanks, July 14, 1894 (No. 451); also near Laramie Peak.

***Paronychia pulvinata*, Gray, Proc. Acad. Phila. 1863, 58.**

Infrequent and strictly alpine; on the naked summits of the Medicine Bow Mountains, August 23, 1895 (No. 1824).

***Paronychia sessiliflora*, Nutt. Gen. i, 160 (1818).**

Common on the slopes about Laramie Peak, August 8, 1895 (No. 1638); observed in some other localities.

***Paronychia* sp.**

Numbers 349, 461, 1331 and 1656 have for the present been laid aside. They represent at least two species not given above, but for want of sufficient literature they are now passed over.

AMARANTACEÆ.

***Amarantus albus*, L. Sp. Pl. Ed. 2, 1404 (1763).**

A troublesome weed in most of our fields and gardens.

Popo Agie River, August 3, 1894 (No. 740); Sheridan Experiment Farm, September 1895.

***Amarantus blitoides*, Wats. Proc. Am. Acad. xii, 273 (877).**

This too would find a place even in a very short list of the worst weeds.

Laramie, September 24, 1894 (No. 1176); Sheridan, September, 1895.

***Amarantus chlorostachys*, Willd. *A. hybridus*, L.**

Some specimens, apparently this, were collected by B. C. Buffum, at Inyan Kara Divide, August 30, 1892.

***Amarantus retroflexus*, L. Sp. Pl. 991 (1753).**

Where weeds run riot this will always be found.

Laramie, October, 1893; Lander, August 3, 1894 (No. 715).

***Amarantus Torreyi*, Benth. Wats. Bot. Cal. ii, 42 (1880).**

Infrequent; near Rawlins, June 29, 1892.

CHENOPODIACEÆ.

Cycloloma platyphyllum, Moq. Enum. Chenop. 18 (1840). *C. atriplicifolium*, Coulter.

Frequent in the sandy canons leading to the Platte, near Fairbanks, July 14, 1894 (No. 471).

Monolepsis chenopodioides, Moq. DC. Prodr. xiii, part 2, 85 (1849). *Monolepsis Nuttalliana*, Greene.

Frequent in saline ground.

Laramie, August, 1893; Boulder Creek, August 26, 1894 (No. 1103).

Chenopodium album, L. Sp. Pl. 219 (1753).

In waste and cultivated ground.

Laramie, October, 1893; Sheridan Experiment Farm, September, 1895. *Pigweed*.

Chenopodium capitatum, Watson, Bot. Cal. ii, 48 (1880).

Infrequent; leaves only, from Cummins, July 27, 1895 (No. 1448).

Chenopodium Fremontii, Watson, Bot. King's Exp. 287 (1871).

Abundant on dry hillsides and on rocky shelving ledges.

Fairbanks, July 13, 1894 (No. 440).

Chenopodium glaucum, L. Sp. Pl. 220 (1753).

Apparently indigenous in places, but scattering everywhere as a weed.

Poison Spider Creek (native?), July 27, 1894 (No. 625); among the weeds at Laramie and Sheridan.

Chenopodium leptophyllum, Nutt. Moq. DC. Prodr. xiii, part 2, 71 (1849).

Not infrequent near the Platte and its tributaries; Laramie, August 15, 1893; Platte River, July 14, 1894 (No. 483).

Chenopodium leptophyllum subglabrum, Wats. Proc. Am. Acad. ix, 95.

Rare; Willow Creek, July 22, 1894 (No. 628).

Chenopodium olidum, Watson, Proc. Am. Acad. ix, 96.

In saline ground on Poison Spider Creek, July 27, 1894 (No. 622); also sent from the Sheridan Experiment Farm as a weed, 1895.

Chenopodium rubrum humile, Watson, Bot. Cal. ii, 48.

Some specimens from Laramie, by B. C. Buffum, June 23, 1894, seem to belong here. Not observed elsewhere.

Atriplex argentea, Nutt. Gen. i, 198 (1818).

Throughout the state ; reported as a weed from some localities.

Big Muddy Creek, July 24, 1894 (No. 640); Meadow Creek, August 9, 1894 (No. 791); Sheridan, September, 1895.

Atriplex canescens, James, Wats. Proc. Am. Acad. ix, 110 (1874).

Not frequent ; observed only on the east side of the Laramie range.

Wheatland, August 11, 1891 ; Platte Hills, Fairbanks, July 14, 1894 (No. 463).

Atriplex confertifolia, Watson, l. c.

A common shrub on the alkali deserts of the central and southwestern parts of the state. Frequently called *White Sage* and is said to be freely eaten by antelope and sheep during the winter months.

Rock Springs, September 9, 1893 ; Bessemer, July 26, 1894 (No. 613).

Atriplex expansa, Watson, Proc. Am. Acad. ix, 116 (1874).

Very abundant in the vicinity of alkali lakes.

Howell Lakes, October 1, 1894 (No. 1164).

Atriplex Nuttallii, Watson, l. c.

Luxuriant in strongly saline ground.

Alkali Desest, July 2, 1891 ; Howell Lakes, October 1, 1894 (No. 1167); alkali flats near Sweetwater River, September 10, 1894 (No. 1192).

Atriplex patula hastata, Gray, Man. Ed. 5, 409 (1867). *A. hastata*. L.

Abundant near Laramie and probably in many other localities. September 1, 1895 (No. 1866). The form with ovate entire leaves was secured at the same time.

Atriplex truncata, Gray, Proc. Am. Acad. viii, 398.

I think there is little doubt of the correctness of this reference.

Rather immature specimens from Poison Spider Creek, July 26, 1894 (No. 621); older at Howell Lakes, October 1, 1894 (No. 1166).

Eurotia lanata, Moq. Enum. Chenop. 81 (1840).

Very frequent and abundant in many localities.

Fairbanks, July 14, 1894 (No. 488); Laramie, September 12, 1894 (No. 1134).

Salicornia herbacea, L. Sp. Pl. 3 (1762).

Abundant on the shores of alkali lakes, even on the encrusted banks where nothing else will grow.

Howell Lakes, October 1, 1894 (No. 1162); Laramie, September 3, 1895 (No. 1869).

Sueda depressa, Watson, Bot. King's Exp. 294 (1871).

Not noted except at Howell Lakes, October 1, 1894 (No. 1163).

Sueda depressa erecta, Watson, Proc. Am. Acad. ix, 90 (1874).

Not frequent; on an alkali bog on Poison Spider Creek, July 27, 1894 (No. 623).

Sueda diffusa, Watson, Proc. Am. Acad. ix, 88 (1874).

This is common on wet, saline ground.

Popo Agie River, August 4, 1894, (No. 717); Sheridan, September, 1895, J. F. Lewis.

Sueda Torreyana, Watson, Proc. Am. Acad. ix, 88 (1874).

Only collected at Howell Lakes, but probably elsewhere as well. October 1, 1894 (No. 1168).

Salsola Kali Tragus, Moq. in DC. Prodr. xiii, part 2, 187 (1849).

This, the much talked of *Russian Thistle*, is already quite widely distributed in the northeastern part of the state. Other plants are frequently mistaken for it and so it has often been reported from localities in which it does not exist. There is no evidence to show that it is found on the line of the Union Pacific railroad except at Cheyenne. On the lines of the Burlington & Missouri and the Elkhorn roads, however, I am reliably informed that it is widely distributed.

Specimens from Cheyenne, October, 1894; from Lusk and Fredericks in 1895.

Sarcobatus vermiculatus, Torr., Emory's Rep. 150 (1848).

The most characteristic shrub of the saline plains and foothills.

Sweetwater River, September 9, 1894 (No. 1182); Howell Lakes, October 1, 1894 (No. 1161). *Grease Wood*.

POLYGONACEÆ.**Eriogonum alatum**, Torr. Sitgreaves Rep. t. 8 (1853).

Noted only on the foothills of the Laramie range and the adjoining plains; abundant.

Cheyenne, August 11, 1891; Laramie Hills, July 9, 1894 (No. 416).

Eriogonum annuum, Nutt. Trans. Am. Phil. Soc. (II) 5: 164 (1833-37).

Infrequent in parts of state collected.

Inyan Kara Divide, September 1, 1892; Willow Creek, July 20, 1894 (No. 566).

Eriogonum brevicaule, Nutt.

Immensely abundant throughout the state on clayey, gravelly ridges and plains.

Laramie Hills, July 8, 1894 (No. 303); Wind River, August 8, 1894 (No. 722); from several other localities.

Eriogonum caespitosum, Nutt. Journ. Acad. Phil. vii, 50 (1834).

Very rare; Union Pass, August 14, 1894 (No. 890).

Eriogonum cernuum, Nutt. Journ. Acad. Phil. (II) 1: 162 (1848).

Widely distributed and abundant.

Laramie Hills, July 7, 1894 (No. 363); Wind River, August 8, 1894 (No. 726).

Eriogonum chrysocephalum, Gray, Proc. Am. Acad. xi, 101.

Rare; possibly confined to the Pacific Slope.

Bacon Creek, August 15, 1894 (No. 903).

Eriogonum flavum, Nutt., Fras. Cat. (1813).

Common on hillsides in the Laramie and Medicine Bow ranges.

Laramie Hills, July 8, 1894 (No. 415); Cummins, July 27, 1895 (No. 1443); a very large form with compound umbels from Laramie Peak, August 5, 1895 (No. 1572).

Eriogonum flavum crassifolium, Benth.

Frequent in the Laramie foothills. Name communicated by Dr. Robinson; citation not at hand.

Laramie Hills June 6, 1894 (No. 186).

Eriogonum heracleoides, Nutt. Journ. Acad. Phila. vii, 49 (1834).

Infrequent; our specimens are not typical but they undoubtedly must be placed here.

Wallace Creek, July 29, 1894 (No. 677).

Eriogonum microthecum, Nutt. Journ. Acad. Phila. (II) 1: 162 (1848).

Both frequent and abundant.

Laramie at various times (Nos. 329 and 1138); Sweetwater, September 12, 1894 (No. 1188).

Eriogonum ovalifolium, Nutt. Journ. Acad. Phila. vii, 50 (1834).

In dry sandy soil on the plains; frequent.

Laramie, May 29, 1894 (No. 70); Hutton ranch, June 19, 1894 (No. 278).

Eriogonum subalpinum, Greene, Pitt. xiii, part 13, 18 (1896).

This recently described species, founded, seemingly, on unimportant characters I believe to be a valid one. The eight specimens in our herbarium labelled *E. umbellatum* fall readily into the two groups made by Prof. Greene. At different times the writer has brought in the two forms from the field fully convinced that they were different and yet unable to separate them by any marked botanical characters, though so readily distinguished in the field.

Laramie Hills, July 7, 1894 (No. 346); Tetons, August 22, 1894 (No. 975); others from Laramie.

Eriogonum umbellatum, Torr. Ann. Lyc. N. Y. ii, 241 (1828).

Pole Creek, July 2, 1895 (No. 1419); Laramie Hills at various times.

Polygonum amphibium, L. Sp. Pl. 361 (1753).

Observed only in the Platte River near Fairbanks, but undoubtedly found elsewhere. July 15, 1894 (No. 551).

Polygonum aviculare, L. Sp. Pl. 362 (1753).

A common dooryard weed.

Laramie, September 24, 1894 (No. 1173). *Goose Grass*.

Polygonum bistortoides, Pursh, Fl. i, 217 (1814).

Frequent in grassy valleys.

Bald Mountain, August 15, 1892; Union Pass, August 11, 1894 (No. 1024).

Polygonum convolvulus, L. Sp. Pl. 364 (1753).

Waste and cultivated ground; Experiment Farm, September 15, 1894 (No. 1140); Popo Agie river, August 1, 1894 (No. 714).

Polygonum Douglasii, Greene, Bull. Cal. Acad. iii, 125 (1885).

In dry ravines; Sybille Creek, July 7, 1894 (No. 307); Laramie Peak, August 7, 1895 (No. 1591).

Polygonum erectum, L. Sp. Pl. 363 (1753).

Infrequent; on the bank of Blue Grass Creek, July 8, 1894 (No. 364).

Polygonum hydropiper, L. Sp. Pl. 361 (1753).

In a wet place on the banks of a small stream near Lusk, July 21, 1894 (No. 576).

Polygonum minimum, Watson, Bot. King Surv. v, 315 (1871).

I refer our specimens to this with some doubt; they are larger than the type and less pubescent.

La Plata Mines, August 24, 1895 (No. 1833)

Polygonum nodosum, Pers. Syn. i, 440 (1805). *P. lapathifolium nodosum*, (Pers.) Small.

From Wheatland, August 1892, by B. C. Buffum.

Polygonum Persicaria, L. Sp. Pl. 362 (1753).

As a weed on the Sheridan Experiment Farm, September 1895, by J. F. Lewis. *Smart Weed*.

Polygonum ramosissimum, Michx. Fl. Bor. Am. i, 237 (1803).

Frequent and variable, some of the specimens approaching *P. Tenue*.

Sugg's Road, August 20, 1892; Wallace Creek, July 29, 1894 (No. 671); Green River, August 14, 1894 (No. 888).

Polygonum viviparum, L. Sp. Pl. 360 (1753).

Frequent in the higher mountains.

Fort Laramie, September 5, 1892; Union Pass, August 11, 1894 (No. 842).

Oxyria digyna, Campd. Rum. 155, t. 3, f. 3 (1819).

Very frequent in shaded places and under overhanging cliffs, 8,000-9000 ft.

Garfield Peak, July 29, 1894 (No. 662); Laramie Peak, August 7, 1895 (No. 1620).

Rumex Crispus, L. Sp. Pl. 335 (1753).

Platte River, July 14, 1894 (No. 495); Laramie, September 20, 1894 (No. 1147).

Rumex maritimus, L. Sp. Pl. 335 (1753).

In saline soil; not frequent.

Clark's Ranch on Wind River, August 10, 1894 (No. 769); Sheridan, September 1895, J. F. Lewis.

Rumex occidentalis, Watson, Proc. Am. Acad. xii, 253 (1876).

Under this name are a number of specimens, some immature, and only the following typical:

Wallace Creek, July 29, 1894 (No. 561); Centennial Valley, August 16, 1895 (No. 1752).

Rumex paucifolius, Nutt. Ms. in Herb. Gray. *R. Geyeri*, (Meisn.) Trelease.

Abundant in subalpine parks; Union Pass, August 11, 1894 (No. 855); also observed in the Medicine Bow Mountains.

Rumex salicifolius, Weinm. Flora, iv, 28 (1813).

Frequent and somewhat variable in general appearance.

Whalen Canon, July 17 1894 (No. 561); Laramie, July 23, 1895 (No. 1449).

Rumex venosus, Pursh, Fl. Am. Sept. 733 (1814).

Frequent about sand dunes on the plains.

Laramie, June 3, 1894 (No. 156).

ELÆAGNACEÆ.

Eleagnus argentea, Pursh, Fl. Am. Sept. 114 (1814).

Very frequent on the Wind Rivers.

Fort Washakie, August 5, 1894 (No. 703).

Shepherdia argentea, Nutt. Gen. ii, 240 (1818). *Lepargyrea argentea*, (Nutt.) Greene. *Buffalo Berry*.

Common on the Platte; Bessemer, July 26, 1894 (No. 636).

Shepherdia Canadensis, Nutt. Gen. ii, 241 (1818). *Lepargyrea Canadensis*, (L.) Greene.

Common on moist and partially shaded slopes in the mountains.

Laramie Hills, May 12, 1894 (No. 25). Garfield Peak, July 29, 1894 (No. 687); Laramie Peak, August 5, 1895 (No. 1585).

LORANTHACEÆ.

Arceuthobium Americanum, Engelm. Pl. Lindl. ii, 214 (1850).

Razoumofskyia Americana, (Engelm.) Kuntze.

Infrequent; at Keystone, Medicine Bow Mountains, 1893, W. C. Knight.

SANTALACEÆ.

Comandra pallida, DC. Prodr. xiv, 636 (1857).

Frequent on dry slopes throughout the state.

Table Mountain, June 2, 1894 (No. 105); Gros Ventre River, August 18, 1894 (No. 1091).

EUPHORBIACEÆ.

Euphorbia dentata, Michx. Fl. Bor. Am. ii, 211 (1803).

Infrequent; observed but once; Hartville, July 15, 1894 (No. 549).

Euphorbia dictyosperma, Fisch. and Mey. Ind. Sem. Hort. Petrop. ii, 37 (1835).

On sand dunes near Mexican Mines, July 21, 1894 (No. 581).

Euphorbia Fendleri, T. & G. Pac. R. R. Rep. ii, 175 (1855).

Our *Euphorbias* seem to be confined to the warm sandy plains and canons of the eastern part of the state, particularly to the region of the Platte. This from Fairbanks, July 14, 1894 (No. 472).

Euphorbia glyptosperma, Engelm. Bot. Mex. Bound. Serv. 187 (1859).

Quite frequent; Wheatland, June 29, 1891; Blue Grass Hills, July 8, 1894 (No. 370).

Euphorbia hexagona, Nutt. Spreng. Syst. iii, 791 (1826).

In a sandy canon leading to the Platte, Fairbanks, July 13, 1894 (No. 436).

Euphorbia montana, Engelm. Bot. Mex. Bound. Surv. 192 (1859).

This is probably common throughout the state on stony, gravelly hillsides.

Inyan Kara Divide, August 29, 1892; Whalen Canon, July 18, 1894 (No. 529); Pole Creek, July 1, 1895 (No. 1400).

Euphorbia petaloidea, Engelm. l. c.

Not infrequent on sandy river bottoms.

Uva, July 10, 1894 (No. 399); Willow Creek, July 22, 1894 (No. 631).

Croton Texensis, Muell. Arg. in DC. Prodr. xv, part 2, 692 (1862).

On sandy river bottoms in the eastern part of the state.

Fairbanks, July 12, 1894 (No. 428); also at Fort Laramie.

URTICACEÆ.

Humulus Lupulus, L. Sp. Pl. 1028 (1753).

Not infrequent in copses on river bottoms and in ravines.

Whalen Canon, July 18, 1894 (No. 513). *Wild Hops.*

Urtica Breweri, Watson, Proc. Am. Acad. x, 348 (1875).

Abundant in Centennial Valley; not observed elsewhere; June 8, 1895 (No. 1273); August 25, 1895 (No. 1862). *Nettle.*

Urtica gracilis, Ait. Hort. Kew. iii, 341 (1789).

Exceedingly abundant in copses on most streams.

Mexican Mines, July 20, 1894 (No. 590).

Parietaria Pennsylvanica, Muhl. Willd Sp. Pl. iv, 955 (1805).

Infrequent; Fairbanks, July 13, 1894 (No. 441).

CUPULIFERÆ.

Betula glandulosa, Mich. Fl. Bor. Am. ii, 180 (1803),

On the stony banks of subalpine streams.

Warm Spring Creek, August 10, 1894 (No. 799). *Mountain Birch.*

Betula occidentalis, Hook. Fl. Bor. Am. ii, 155 (1839).

Supposedly common on our streams, especially in the northeast, but only collected at Laramie Peak, August 8, 1895 (No. 1647). *Western Birch.*

Alnus incana virescens, Wats. Bot. Cal. ii, 81 (1880).

Frequent and abundant on our mountain streams, sometimes attaining the size of small trees.

Big Wind River, August 8, 1894 (No. 728); Cummins, July 29, 1895 (No. 1531); also in Centennial Valley. *Alder.*

Quercus undulata, Torr. Ann. Lyc. N. Y. ii, 248 (828).

This is reported abundant in the Black Hills, to which region it is probably confined; so far as known it is our only *Oak*.

Sundance, July 22, 1891, by B. C. Buffum.

SALICACEÆ.*

Salix arctica petræa, Anders.

Infrequent; not observed by the writer.

Collected by B. C. Buffum, Bald Mountain, August 15, 1892.

Salix alba x fragilis, Wienmer.

This Hybrid is among those in the City Park, October 1, 1894 (No. 1199).

Salix amygdaloides, Anders. Ofv. Handl. Vet. Akad. 1858, 114 (1858).

Typical specimens from Snake River, August 21, 1894 (No. 978).

My specimens from Big Popo Agie River, August 2, 1894 (No. 738)

* The *Willows* were in large part determined by the late Mr. Bebb; those collected in 1895 only, by Mr. M. L. Fernald.

were designated by Mr. Bebb as "*forma sat singularis*," on account of the occurrence in the same individual of the following peculiarities: Leaves unusually short and broad, coarsely serrate and very conspicuously stipulate.

Salix candida, Fleugge, Willd. Sp. Pl. iv, 708 (1806).

Observed only in Centennial Valley, August 20, 1895 (No. 1755).

Salix chlorophylla, Anders. Monogr. 138 (1867).

Widely distributed; Union Pass, August 13, 1894 (No. 1029); Centennial Valley, August 19, 1895 (No. 1741).

Salix cordata, Muhl. Neue Schr. Ges. Nat. Fr. Berlin, iv, 236 (1803).

Collected but once; Laramie Peak, August 6, 1895 (No. 1598).

Salix curtiflora, (Anders.) Bebb.

This very rare plant from two localities; not reported from this state before, I think, except by Mr. Tweedy.

Boulder Creek, August 26, 1894 (No. 1122); Centennial Valley, August 19, 1895 (No. 1754).

Salix desertorum, Rich. App. Frank. Journ. 371 (823).

On a hummocky heath in Centennial Valley, August 20, 1895 (No. 1759).

Salix desertorum elata, Anders.

Rare, alpine; Union Peak, August 13, 1894 (No. 1072); LaPlata Mines, August 22, 1895 (No. 1818).

Salix desertorum fruticulosa, Anders.

Infrequent in an open, heathlike park in Union Pass, August 11, 1894 (No. 913).

Salix flavescens, Nutt. Sylv. i, 65 (1842-53).

This beautiful species is the first to put out its blossoms of all our willows; the leaves follow very tardily.

Thus far noted only in the Laramie range; Pole Creek, May, 12, 1894 (No. 24) and at various other times; Laramie Peak, August 6, 1895 (No. 1586).

Salix lasiandra Fendleriana, (Anders.) Bebb.

Not infrequent; Popo Agie River, August 2, 1894 (No. 737); Pole Creek, June 30, 1895 (No. 1434).

Salix leucosericea, Nob. n. sp.

In communicating this name to me Mr. Bebb made the following comments upon the species: "It will shortly appear as above in a

government report. This is the Rocky Mountain or plateau member of a group which has for its eastern or Atlantic coast representatives, *S. sericea* and *S. petiolaris*, and for the Pacific coast *S. macrocarpa*."

Rare; observed only on Boulder Creek, August 26, 1894 (No. 1123).

Salix longifolia, Muhl. Neue Schr. Ges. Nat. Fr. Berlin, iv, 238 (1803).

On sand bars and creek banks everywhere, common and variable.

Laramie, June 16, 1894 (No. 245); near Lander, August 3, 1894 (No. 718); Cummins, July 26, 1895; (No. 1447).

Salix macrocarpa, Nutt.

I suppose this to be very rare in the state.

Centennial Valley, June, 9, 1895 (No. 1255).

Salix monticolo, Bebb.

Infrequent; Centennial Valley, August 18, 1895 (No. 1733).

Salix rostrata, Richards, Frank. Journ. App. 753 (1823).

Our commonest *Willow*.

Laramie, June 16, 1894 (No. 244); Centennial Valley, June 9, 1895 (No. 1303); also a low mountain form from Little Sandy, August 30, 1894 (No. 1130).

Salix sp.

Only foliage but clearly enough not any of the foregoing.

Populus acuminata, Rydberg, Bull. Torr. Club, xx, 50 (1893).

Our handsomest *Cottonwood* as well as the most rapid growing of our shade trees; planted extensively in Laramie.

Fine native specimens in Whalen Conon, July 17, 1894 (No. 560).
Rydberg's Cottonwood.

Populus angustifolia, James, Long's Exp. i, 497 (1823).

This is very frequent on the principal streams of the state, in places forming considerable bordering groves, individual trees attaining great size.

Laramie, May 16, 1894 (No. 39). *Black Cottonwood*.

Populus balsamifera, L. Sp. Pl. 1034 (1753).

This is not frequent and I have not seen it except as single trees here and there.

Dubois, August 9, 1894 (No. 749); Cummins, July 29, 1894 (No. 1547).

Populus monilifera, Ait. Hort Kew. iii, 406 (1789).

This species is used to some extent for shade purposes. If native in the state I have not yet observed it.

Populus tremuloides, Michx. Fl. Bor. Am. ii, 243 (1803).

The *Quaking Asp* of the canons and hillsides, usually only a large shrub but in some places attaining considerable size as trees.

Laramie Hills, May, 12, 1894 (No. 23); noted in scores of other places.

HYDROCHARITACEÆ.

Elodea Canadensis, Michx. Fl. Bor. Am. i, 20 (1803). *Udora Canadensis*, Nutt.

In the ponds and springs on the Fish Hatchery grounds where it has probably been introduced. October 18, 1893.

ORCHIDACEÆ.

Calypso borealis, Salisb. Parad. Lond. t. 89 (1807). *C. bulbosa*, (L.) Oakes.

This beautiful little *Orchid* is as rare here as elsewhere. The following students each found one specimen on a partly wooded hillside at the head of Pole Creek, May 25, 1894 (No. 61): Lily Boyd, Tessie Welch and Ben Bartlett

Listera convallarioides, (Sw.) Torr. Comp 320 (1826).

Very rare, only observed once; Centennial Valley, August 17, 1895 (No. 1694).

Spiranthes Romanzoffiana, Cham. Linnæa, iii, 32 (1828). *Gyrostachys Romanzoffiana*, (Cham.) MacM.

Abundant in a few localities; Centennial Valley, August 10, 1895 (No. 1663).

Habenaria gracilis, (?) Watson.

The following numbers, (420 and 1706) appear in our herbarium as *H. hyperborea*, but re-examination shows that they should probably be referred as above. Frequent in marshy places.

Chugwater Creek, July 7, 1894; Centennial Hills, August 17, 1895.

Habenaria hyperborea, R. Br. in Ait. Hort. Kew, Ed. 2, v, 203 (1813).

Specimens only from Big Wind River, August 8, 1894 (No. 725).

Habenaria obtusata, Richards. App. Frank. Journ. 750 (1823).

Very rare; Cummins, July 30, 1895 (No. 1544).

IRIDACEÆ.

Iris Missouriensis, Nutt. Journ. Acad. Phila. vii, 58 (1834).

Frequent on creek and river bottoms.

Laramie, June 18, 1894 (No. 260); Centennial Valley, June 9, 1895 (No. 1268).

Sisyrinchium Bermudiana, L. Sp. Pl. 954 (1753).

The specimens before me show the characters which were supposed to separate *S. angustifolius* and *S. mucronatum*, but the length of the spathes and the breadth of the wings are far from constant. It is well to unite them under this earlier name.

Laramie, June 1894 (No. 239); Wind River, at Dubois, August 10, 1894 (No. 767); in various other places.

LILIACEÆ.

Streptopus amplexifolius, DC. Fl. Fran. iii, 174 (1805).

In copses on mountain sides; Laramie Hills, June 28, 1891; Laramie Peak, August 6, 1895 (No. 1589).

Smilacina amplexicaulis, Nutt. Journ. Acad. Phil. vii, 58 (1834).

Vagnera amplexicaulis, (Nutt.) Greene.

Very rare; thus far only observed on Casper Mountain, July 26, 1894 (No. 610).

Smilacina stellata, Desf. Ann. Mus. Paris, ix, 52 (1807). *Vagnera stellata*, (L.) Greene.

Frequent and abundant in the meadows bordering on all our streams.

Horse Creek, June 9, 1894 (No. 155); Platte River, July 24, 1894 (No. 632).

Yucca angustifolia, Pursh. Fl. Am. Sept. 227 (1814). *Y. glauca*, Nutt.

Frequent on sandy, gravelly hillsides.

Cummins, July 27, 1895 (No. 1460). *Spanish Bayonet*.

Leucocrinum montanum, Nutt. Gray, Ann. N. Y. Lyc. iv, 110 (1837).

Very common on the plains and foothills.

Laramie, May 15, 1894 (No. 1226); also from Table Mountain. *White Mountain Lily*.

Allium acuminatum, Hook. Fl. Bor. Am. ii, 184, t. 146 (1840).

On the Platte River, 1891, B. C. Buffum.

Allium brevistylum, Watson, Bot. King Exp. 350 (1871).

Frequent in rich loam soil in copses.

Big Horn Mountains, July 1892; Centennial Hills, August 1895 (No. 1704).

Allium cernuum, Roth. Roem. Arch. Bot. i, part 3, 40 (1798).

Very frequent; Inyan Kara Divide, August 31, 1892; Garfield Peak, July 29, 1894 (No. 661); Laramie Peak, August 7, 1895 (No. 1633).

Allium Nuttallii, Wats. Proc. Am. Acad. xiv, 227 (1879).

Not infrequent on gravelly river bottoms and hillsides.

Laramie, June 19, 1894 (No. 263); Pole Creek, June 30, 1895 (No. 1382).

Allium reticulatum, Don. Mem. Wern. Soc. vi, 36 (1826-31).

The earliest and commonest *Wild Onion* on the plains.

Laramie, June 15, 1894 (No. 222); Pole Creek, June 29, 1895 (No. 1353).

Allium Schönoprasum, L. Sp. Pl. 301 (1753).

In wet places in the mountains.

Green River, August 15, 1894 (No. 907); La Plata Mines, August 23, 1895 (No. 1788).

Fritillaria atropurpurea, Nutt. Journ. Acad. Phila. vii, 54 (1834).

This is very rare; single specimens from the east slope of the Laramie Hills in June by B. C. Buffum, and on two occasions by Noah Wallis.

Erythronium grandiflorum, Pursh. Fl. i, 231 (1814).

Infrequent; alpine or at least subalpine.

Bald Mountain, August 16, 1892; La Plata Mines, August 22, 1895 (No. 1796).

Calochortus Gunnisoni, Wats. Bot. King's Exp. 348 (1871).

Among the sage brush in the valleys.

Sybilie Creek, July 8, 1894 (No. 319); Cummins, July 26, 1895 (No. 1451).

Calochortus Nuttallii, T. & G. Pac. R. R. Rep. ii, 124 (1855).

In similar locations and nearly resembling the preceding but for the anthers and glands.

Laramie Hills, June 18, 1891; also July 7, 1894 (No. 413).

Disporum trachycarpum, B. & H. Gen. Pl. iii, 832 (1883).

In copses on mountain rivulets.

Casper Mountain, July 26, 1894 (No. 609); Centennial Valley,
June 9, 1895 (No. 1277).

Zygadenus elegans, Pursh. Fl. Am. Sept. 241 (1814).

Frequent; in wet, grassy places near streams.

Chugwater Creek, July 7, 1894 (No. 421); Cummins, July 27,
1895 (No. 1453).

Zygadenus Nuttallii, Wats. Proc. Am. Acad. xiv, 279 (1879).

Abundant on sandy plains and in the foothills.

Laramie, June 16, 1894 (No. 254); observed in many localities.

COMMELINACEÆ.**Tradescantia Virginiana**, L. Sp. Pl. 288 (1753).

Probably confined to the eastern part of the state.

Platte River, July 14, 1894 (No. 492).

JUNCACEÆ.***Juncus Balticus**, Willd. Berlin Mag. iii, 298 (1809).

Very frequent in wet ground near streams.

Laramie, June 16, 1894 (No. 243).

Juncus bufonius, L. Sp. Pl. 328 (1753).

Frequent about spring bogs and in occasionally flooded ditches.

Cold Springs, Fairbanks, July 13, 1894 (No. 437); Centennial
Valley, August 25, 1895 (No. 1851).

Juncus longistylis, Torr. Bot. Mex. Bound. Surv. 223 (1859).

Infrequent; Centennial Valley, August 18, 1895 (No. 1716).

Juncus Mertensianus, Bong.

This is of frequent occurrence in the higher mountains.

La Plata Mines, August 22, 1895 (No. 1791).

Juncus nodosus, L. Sp. Pl. Ed. 2, 466 (1762).

Frequent; Laramie, September 1892; Little Sandy, July 1892;

Wolf Creek, August 1892, by B. C. Buffum.

* For some further notes upon this and the order *Cyperaceæ*, see Bulletin No. 16 of this Station, by B. C. Buffum.

- Juncus Parryi**, Engelm. Trans. St. Louis Acad. ii, 447 (1866).
Alpine; Teton Mountains, August 21, 1894 (No. 981); La Plata Mines, August 24, 1895 (No. 1831).
- Juncus subtriflorus**, (Mey.) Coville, Contrib. Natl. Herb. iv, 208 (1893).
La Plata Mines, at about 11,000 ft., August 23, 1895 (No. 1812).
- Juncus tenuis**, Willd. Sp. Pl. ii, 214 (1799).
Lander, August 3, 1894 (No. 699).
- Juncus tenuis congesta**, Engelm. Trans. St. Louis Acad. ii, 446 (1866).
Infrequent; Laramie Peak, August 7, 1895 (No. 1631).
- Juncus Torreyi**, Coville.
Cold Springs, July 14, 1894 (No. 449); Teton Mountains, August 21, 1894 (No. 956).
- Juncus xiphioides montanus**, Engelm. Trans. St. Louis Acad. ii, 481 (1868).
Centennial Valley, August 18, 1895 (No. 1731).
- Luzula spadicea parviflora**, Meyer, Linnæa, xxii, 402 (1849). *Juncoides parviflorum*, (Ehrh.) Coville.
Not infrequent; Union Pass, August 11, 1894 (No. 846).
- Luzula spadicea subcongesta**, Watson, Bot. Cal. ii, 202.
In boggy places and partially dried up ponds.
Centennial Valley, August 16, 1895, and June 9, 1895 (No. 1261).
- Luzula spicata**, DC. Fl. Fr. iii, 161 (1805). *Juncoides spicatum*, (L.) Coville.
Alpine; Union Pass, August 11, 1894 (No. 847); noted also in the Medicine Bow Mountains

TYPHACEÆ.

- Typha latifolia**, L. Sp. Pl. 971 (1753).
Common in the margins of lakes and ponds.
Popo Agie River, August 1, 1894 (No. 734); abundant in the vicinity of Laramie.

ALISMACEÆ.

- Alisma Plantago**, L. Sp. Pl. 342 (1753).
Rare; not observed by the writer.
Dutch Creek, Sheridan County, 1892, by B. C. Buffum.

Sagittaria arifolia, (?) Nutt. in Herb. *S. variabilis minor*, Pursh.

I have some hesitancy in referring it as above, but it is the best disposition I can make of it at present.

Collected in a marshy meadow stream near Lusk, July 21, 1894 (No. 577).

Sagittaria latifolia, Willd. Sp. Pl. iv, 409 (1806).

Probably rare; Wheatland, August 11, 1891, B. C. Buffum.

NAIADACEÆ.

Triglochin maritima, L. Sp. Pl. 339 (1753).

Common in alkali marshes.

Alkali Springs, July 30, 1894 (No. 745); also from Wind River, Laramie and other localities.

Triglochin palustris, L. Sp. Pl. 388 (1753).

In similar locations; Wind River, August 8, 1894 (No. 759).

Potamogeton pectinatus, L. Sp. Pl. 127 (1753).

In the Laramie River, August 9, 1895 (No. 1668.)

CYPERACEÆ.

Eleocharis compressa, Sull. Am. Journ. Sci. lxii, 50 (1842). *E. acuminata*, (Muhl.) Nees.

As yet only from the Big Horn Mountains, July 1892, B. C. Buffum.

Eleocharis olivacea, Torr. Ann. Lyc. N. Y. iii, 300 (1836).

Not infrequent in partially submerged ground.

Laramie, June 28, 1894 (No. 289); Cold Springs, July 14, 1894 (No. 455).

Eleocharis ovata, Roem. & Schult. Syst. ii, 152 (1817).

Specimens in the World's Fair collection secured in 1892.

Scirpus atrovirens, Muhl. Gram. 43 (1817).

Very common in marshy ground about springs and ponds.

Mexican Mines, July 20, 1894 (No. 591); Muddy Creek, August 25, 1894 (No. 1109).

Scirpus lacustris, L. Sp. Pl. 48 (1753).

Rare; noted only at Cold Springs, Fairbanks, July 14, 1894 (No. 454).

- Scirpus pungens**, Vahl. Enum ii, 255 (1806). *S. Americanus*, Pers.
Frequent; Cold Springs, Fairbanks, July 14, 1894 (No. 450).
- Scirpus sylvaticus digynus**, Boeckl. Linnæa, xxxvi, 727 (1870). *S. microcarpus*, Presl.
Infrequent; excellent specimens from Laramie Peak, August 6, 1895 (No. 1805).
- Eriophorum polystachyon**, L. Sp. Pl. 52 (1753).
Infrequent; Crazy Woman Creek, August 7, 1892, B. C. Buffum.
- Carex alpina**, Sw. Lilj. Sv. Fl. Ed. 2, 26, (1798).
Probably rather rare; head of Crazy Woman Creek, August 7, 1892.
- Carex athrostachya**, Olney, Proc. Am. Acad. vii, 393 (1868).
From Saratoga, August 1892.
- Carex atrata**, L. Sp. Pl. ii, 976 (1753).
Infrequent; alpine; La Plata Mines, August 23, 1895 (No. 1811).
- Carex aurea**, Nutt. Gen. ii, 205 (1818).
Rare; Wolf Creek, August 18, 1892, B. C. Buffum.
- Carex canescens**, L. Sp. Pl. 974 (1753).
Centennial Hills, August 18, 1895 (No. 1730).
- Carex deflexa media**, Bailey, Mem. Torr. Club. i, 42 (1889).
Big Sandy, July 1892, B. C. Buffum.
- Carex Douglasii**, Boott. Hook. Fl. Bor. Am. ii, 213, t. 214 (1840).
Secured in the Big Horn Mountains, August 8, 1892, B. C. Buffum.
- Carex festiva**. Dew. Am. Journ. Sci. xxix, 246 (1836).
Very abundant and apparently throughout the state.
Big Sandy, July, 1892; Laramie, June 28, 1894 (No. 288); also from Laramie Peak and Medicine Bow Mountains, in 1895 (Nos. 1615 and 1786).
- Carex filifolia**, Nutt. Gen. ii, 204 (1818).
Infrequent; Wheatland, August, 1891.
- Carex geyeri**, Boott. Trans. Linn. Soc. xx, 118 (1846).
Big Sandy, July, 1892, B. C. Buffum.
- Carex Liddoni**, Boott.
Big Horn Mountains, July 1892, B. C. Buffum.
- Carex marcida**, Boott. Hook. Fl. Bor. Am. ii, 212, t. 213 (1840).
In Carbon County, June 1892, B. C. Buffum.

Carex Nebraskensis, Dewey, Am. Journ. Sci. (II) xviii, 102 (1854).

This is a very common species in wet soil everywhere, even in soils with a considerable percentage of alkali; Laramie, June 19, 1894 (No. 274); Table Mountain, June 2, 1894 (No. 130).

Some specimens by B. C. Buffum are marked *C. Nebraskensis pravia*, Bailey, and it is not clear from the specimens nor from the literature at hand that they are different from the species.

Carex occidentalis, Bailey.

Apparently rare; Laramie Peak, August 6, 1895 (No. 1614).

Carex Pennsylvanica, Lam. Encycl. iii, 388 (1789).

Common on fertile hillsides among sage brush and other undershrubs.

Crook county August, 1892; Pole Creek, May 25, 1894 (No. 69).

Carex pratensis, Drejer, Rev. Crit. Car. Bor. 24 (1841).

Head of Crazy Woman Creek, August 8, 1892, B. C. Buffum.

Carex Raynoldsii, Dew. Am. Journ. Sci. xxxii, 39 (1837).

Infrequent; Bald Mountain, August 15, 1892, B. C. Buffum.

Carex siccata, Dew. Am. Journ. Sci. x, 278 (1826).

Abundant in native meadows on alkali soil.

Laramie, June 1, 1894 (No. 65).

Carex stenophylla, Wahl. Kongl. Acad. Handl. (II.) xxiv, 142 (1803).

Exceedingly abundant on the Laramie Plains in both dry and wet soil, the earliest *Sedge*, springing up as almost the first vegetation.

Laramie, May 16, 1894 (No. 19); at various other times.

Carex straminea brevior, Dew.

Rare; Lusk, July 21, 1894 (No. 586).

Carex straminea mirabilis, (Dew.) Tuck. Enum. Meth. 18 (1843).

Specimens communicated by J. F. Lewis, of the Sheridan Experiment Farm, September 1, 1895.

Carex tenella, Schk. Riedgr. 23, Fig. 104 (1801).

Some specimens from Wolf Creek, August 18, 1892, B. C. Buffum.

Carex Tolmiei, Boott.

Table Mountain, June 2, 1894 (No. 100); also from the Big Horn Mountains, August 6, 1892, B. C. Buffum.

Carex utriculata, Boott. Hook. Fl. Bor. Am. ii, 221 (1840).

Infrequent; Muddy Creek, August 25, 1894 (No. 1108).

Carex utriculata minor, Boott. l. c.

This seems to be of more frequent occurrence than the species.

Saratoga, 1891, by J. D. Parker ; Laramie River, in Laramie county, September, 1892, B. C. Buffum.

Carex sp.

Somewhat resembling *C. Nebraskaensis*, but with culms several times as long as the leaves ; spikes few, the terminal one much the longer.

Cold Springs, at Fairbanks, July 13, 1894 (No. 447).

GRAMINEÆ.*

Andropogon provincialis, Lam. Encycl. i, 376 (1783).

Common in the eastern part of the state.

Wheatland, July, 1892, B. C. Buffum.

Andropogon scoparius, Michx. Fl. Bor. Am. i, 57 (1803).

Frequent ; Hartville, July 18, 1894 (No. 531); also by B. C. Buffum, 1892.

Panicum capillare, L. Sp. Pl. 58 (1753).

Common in all parts of the state.

Crook county, 1892 ; Fairbanks, July 15, 1894 (No. 553); Sheridan Experiment Farm, September 1, 1894. *Old Witch Grass*.

Panicum Crus-galli, L. Sp. Pl. 56 (1753).

Presumably introduced but often found where such introduction would not be suspected.

Cummins, July 29, 1895 (No. 1500); Sheridan, September 1, 1895. J. F. Lewis.

Panicum sanguinale, L. Sp. Pl. 57 (1753).

Very generally introduced. Lander, June 1892 ; noted in other localities.

Panicum scoparium, Lam. Encycl. iv, 744 (1797).

Infrequent ; Whalen Canon, July 18, 1894 (No. 516).

Panicum virgatum, L. Sp. Pl. 59 (1753).

Fort Laramie, September, 1892, B. C. Buffum ; Sheridan, September, 1895.

* The Grasses were determined in part by each of the following : Dr. W. J. Beal, Dr. F. Lamson-Scribner and Prof. B. C. Buffum. For further notes upon them see "Grasses and Forage Plants," Bulletin No. 16 of this Station, by B. C. Buffum.

- Setaria viridis**, Beauv. Agrost. 51 (1812). *Chamaeraphis viridis*, (L.) Porter.
A troublesome weed in cultivated ground.
Wheatland, August 11, 1891. *Meadow Fox-tail*.
- Oenchrus tribuloides**, L. Sp. Pl. 1050 (1753).
Common on the sandy plains of the Platte.
Fort Laramie, September 5, 1892, B. C. Buffum. *Sand Bur*.
- Phalaris arundinacea**, L. Sp. Pl. i, 55 (1753).
Collected in 1891; no other data.
- Hierochloa borealis**, R. & S.
Not frequent; Bald Mountain, August 15, 1892.
- Aristida purpurea**, Nutt. Trans. Am. Phil. Soc. (II.) v, 145 (1833-37).
A. fasciculata, Torr.
Whether specimens are typical or belong to one of the varieties of this species I am unable to say. This form is common in the state.
Wheatland, July, 1891; Whalen Canon, July 19, 1894 (No. 539).
- Stipa comata**, Trin. and Rupr. Mem. Acad. St. Petersburg. (VI) v, 75 (1842).
Frequent on the plains and in dry valleys; when mature an annoying and worthless grass.
Laramie, June 17, 1891; June 28, 1894 (No. 284).
- Stipa spartea**, Trin. Mem. Acad. St. Petersburg. ser. 6, i, 82 (1829).
On the plains of the eastern part of the state, 1891.
- Stipa viridula**, Trin. Mem. Acad. St. Petersburg. ser. 6, v, 39 (1836).
Big Sandy, Fremont county. July, 1892.
- Oryzopsis exigua**, Thurb. Bot. Wilkes Exp. 481.
Hitherto, it seems, reported only from Oregon and Washington.
Big Sandy, in the Wind River Mountains, July 22, 1892, B. C. Buffum.
- Oryzopsis membranacea**, Vasey, Grasses S. W. part 2, t. 10 (1891).
Very abundant on the plains and in the foothills.
University Campus, September 18, 1894 (No. 1137); noted in many other places. *Mountain Rice*.
- Muhlenbergia comata**, Benth. Vasey's Cat. Grasses U. S. 39 (1885).
Spring Creek, Big Horn Mountains, August 5, 1892.

- Muhlenbergia dumosa**, Scrib. in Vasey, Contr. Nat. Herb. iii, 71.
Frequent in the eastern part of the state.
Wheatland, August 16, 1891.
- Muhlenbergia glomerata**, Trin. Unif. 191 (1824). *M. racemosa*,
(Michx.) B. S. P.
From Wolf Creek, Rawhide Creek and Fort Laramie, 1892, B.
C. Buffum.
- Muhlenbergia gracilis breviaristata**, Vasey, Rothr. in Wheeler's
Rep. vi, 284.
Plumbago Canon, July 1891.
- Phleum alpinum**, L. Sp. Pl. 59 (1753).
Common in the alpine region of all our mountain ranges.
Union Pass, August 10, 1894 (No. 863); La Plata, August 22,
1895 (No. 1781). *Wild Timothy*.
- Alopocurus geniculatus fulvus**, (J. E. Smith) Scrib. List. Pterid &
Sperm. 38 (1894).
Frequent; Whalen Canon, July 19, 1894 (No. 544); Centennial
Valley, August 18, 1895 (No. 1721).
- Sporobolus airoides**, Torr. Pac. R. R. Rep. vii, part 3, 21 (1856).
Fort Washakie Hot Springs, July, 1892, B. C. Buffum.
- Sporobolus asperifolius**, Thurb. in Wats. Bot. Cal. ii, 269 (1880).
Probably infrequent; Cheyenne, August, 1891.
- Sporobolus cryptandrus**, Gray, Man. 576 (1848).
Rather frequent, on dry ridges.
Wheatland, September 8, 1892; Fairbanks, July 13, 1894 (No.
435).
- Sporobolus cuspidatus**, Scribn. Bull. Torr. Club, x, 63 (1882). *S. brev-*
ifolius, (Nutt.) Scribn.
Fremont county, July, 1892.
- Sporobolus heterolepis**, Gray, Man. 576 (1848).
Crook county, August, 1892.
- Agrostis alba**, L. Sp. Pl. 63 (1753).
Common; Crook county, 1892; Laramie, October 6, 1894 (No.
1172).
- Agrostis asperifolia**, Trin. Mem. Acad. St. Petersb. Sci. Nat. ser. 6,
318 (1845).
Infrequent; Centennial Valley, August 18, 1895 (No. 1719).

Agrostis exarata, Trin. Unifl. 207 (1824).

Head of Rawhide Creek, August 1892.

Agrostis humilis, Vasey, Bull. Torr. Club, x, 21.

Alpine, in wet soil; La Platta Mines, August 23, 1895 (No. 1814).

Agrostis scabra, Willd. Sp. Pl. i, 370 (1798).

Frequent; Big Sandy, July, 1892; Albany county, September, 1891.

Calamagrostis Canadensis, Beauv. Agrost. 15 (1812).

Wind River Mountains, July, 1892.

Calamagrostis confinis, Nutt. Gen. i, 47 (1818).

Common; Centennial Valley, September 7, 1891; Laramie, September 30, 1894 (No. 1179).

Calamagrostis longifolia, Hook. Fl. Bor. Am. 241 (1840). *Calamovilfa longifolia*, (Hook.) Hack.

Frequent; Lander, July, 1892; Whalen Canon, July 9, 1894 (No. 536).

Calamagrostis Montanensis, Scribn.

Sheridan county, August, 1892.

Calamagrostis neglecta, (Ehrh.) Gærtn. Fl. Wett. i. 94 (1799).

Frequent; Big Horn Mountains, August, 1892; Orin Junction, August 14, 1891.

Calamagrostis pallida, Vasey & Scribn.

Eagle Rock Canon, September 22, 1891; also from Carbon county.

Calamagrostis purpurascens, R. Br., in Rich. Bot. App. Frank. Voy. 3.

Infrequent; Laramie Peak, August 7, 1895 (No. 1627).

Deschampsia cæspitosa, Beauv. Agrost. 160, t. 18, f. 3 (1812).

Common in the mountains; Big Sandy, July, 1892; La Plata Mines, August 23, 1895 (No. 1815).

Deschampsia cæspitosa arctica, Vasey.

Rare; Laramie Hills, June 12, 1894 (No. 238).

Trisetum subspicatum, Beauv. Agrost. 180 (1812).

Very abundant in the mountains; Big Sandy, July, 1892; La Plata Mines, August 22, 1895 (No. 1783).

Trisetum subspicatum molle, Gray, Man. Ed. 2, 572 (1856).

La Plata, Medicine Bow Mountains, August 23, 1895 (No. 1807).

Trisetum Wolfii, Vasey.

Fort Laramie, September 6, 1892, B. C. Buffum.

- Danthonia Californica**, Boland. Proc. Cal. Acad. ii, 182 (1862-63).
Sheridan county, August, 1892.
- Danthonia intermedia**, Vasey.
Big Sandy, Fremont county, July, 1892.
- Danthonia unispicata**, Munro. *D. Californica unispicata*, Thurb.
Bot. Cal. ii, 294 (1880).
Apparently rare; Laramie Peak, August 7, 1895 (No. 1630).
- Spartina cynosuroides**, Willd Enum. Pl. 80 (1809).
Common and widely distributed; Inyan Kara Divide, August 30, 1892; C. Y. Ranch, on Big Muddy, July 23, 1894 (No. 599).
- Schedonnardus Texanus**, Steud. Syn. Pl. Gram. 146 (1855). *S. paniculatus*, (Nutt.) Scribn.
Abundant on the plains of the eastern part of the state.
Orin Junction, August, 1891.
- Bouteloua oligostachya**, Torr. Gray, Man. Ed. 2, 553 (1856).
A very common grass on the plains.
Wheatland, June 11, 1891; noted in many localities.
- Bouteloua racemosa**, Lag. Var. Clenc. y Litter. 2: Part 4, 141 (1805).
B. curtipendula, (Michx.) Torr.
This, like the preceding, is very abundant in many localities.
Inyan Kara Divide, August 30, 1892; Hartville, July 18, 1894 (No. 530).
- Beckmannia erucæformis**, Host. Gram. Austr. iii, 5 (1805).
In swampy ground along our streams.
Big Sandy, July, 1892; Union Pass, August 11, 1894 (No. 828);
Cummins, July 30, 1895 (No. 1533).
- Buchloe dactyloides**, Engelm. Trans. St. Louis Acad. i, 432 (1859).
Bulbilis dactyloides, (Nutt.) Raf.
This is still found in considerable abundance on some of our plains, but it seems that it is gradually being killed out and replaced by other grasses.
Wheatland, September, 1892, and noted in many parts of the state. *Buffalo Grass*.
- Munroa squarrosa**, Torr. Pac. R. R. Rep. iv, 158 (1856).
Noted only in the eastern part of the state,
Wheatland, August, 1891; Blue Grass Creek, July 8, 1894 (No. 372).

Phragmites communis, Trin. Fund. Agrost. 134 (1820). *P. Phragmites*, (L.) Karst.

Not noted by the writer, but fine specimens by B. C. Buffum, from Little Muddy Creek, Casper, August 12, 1891. *Reed Grass*.

Eragrostis major, Host. Gram. Austr. 4: 14, t. 24 (1809).

Sparingly introduced about Wheatland and probably in other localities; September, 1892, B. C. Buffum.

Eatonia obtusata, Gray, Man. Ed. 2, 558 (1856).

Frequent; Crook county, August, 1892; Fairbanks, July 14, 1894 (No. 459).

Koeleria cristata, Pers. Syn. i, 97 (1812).

Common everywhere; Johnson county, August, 1892; Laramie, June 28, 1894 (No. 283), and noted in numerous localities.

Catabrosa aquatica, Beauv. Agrost. 157, t. 19, f. 8 (1812).

Throughout the state; Crook Creek, June 28, 1891; Cottonwood Canon, August 4, 1895 (No. 1567).

Melica bulbosa, Geyer.

Infrequent; Bald Mountain, August 16, 1892.

Distichlis maritima, Raf. Journ. Phys. lxxxix, 104 (1818). *D. spicata*, (L.) Greene.

Frequent on wet alkali flats.

Big Wind River, August 1, 1892; Alkali Springs, July 31, 1894 (No. 659).

Poa alpina, L. Sp. Pl. 67 (1753).

Rare, as well as rarely beautiful; Bald Mountain, August 15, 1892.

Poa andina, Nutt. Wats. Bot. King Exp. 388 (1871). *P. arida*, Vasey.

Common on dry slopes; Middle Pass, June 21, 1892; Laramie, June 5, 1895 (No. 1245).

Poa Californica, Vasey, Cat. Grasses, U. S. 81 (1885). *P. Fendleriana*, (Steud.) Vasey.

Infrequent; Big Sandy, July, 1892.

Poa cæsia strictior, Gray.

Laramie Hills, June, 1892, B. C. Buffum.

Poa cuspidata, Vasey.

Carbon county, June, 1892; La Plata Mines, August 22, 1895 (No. 1782).

Poa lævis, Vasey.

Carbon county, June, 1892.

Poa nemoralis, L. Sp. Pl. 69 (1753).

This is of frequent occurrence; Big Sandy, July, 1892; Laramie, June 19, 1894 (No. 272).

Poa Nevadensis, Vasey, Bull. Torr. Club, x, 66 (1883).

I am unable to say whether this is frequent or not. I notice it mentioned by others as a valuable forage grass. Specimens at hand only from Big Sandy, July, 1892.

Poa occidentalis, Vasey.

This fine species is common on the streams near Laramie; Fish Hatchery, July, 1891; Laramie River, June 22, 1895 (No. 1317).

Poa pratensis, L. Sp. Pl. 67 (1753).

Collected in 1892 for the World's Fair exhibit; common. *Blue Grass*.

Poa reflexa, Vasey & Scribn.

An alpine or subalpine species.

Bald Mountain, August 16, 1892; La Plata Mines, August 24, 1895 (No. 1837).

Poa rupestris, Vasey.

Rare; noted but once at 11,000 ft.; La Plata Mines, August 23, 1895 (No. 1813).

Poa serotina, Ehrh. Beitr. vi, 83 (1793). *Poa flava*, L.

Cheyenne, August 11, 1891. *False Red Top*.

Poa tenuifolia, Nutt. Buckley, Proc. Acad. Phila. 1862, 96 (1862).

Very common throughout the state.

Big Sandy, July, 1892; Laramie Hills, May 23, 1894 (No. 49).
Bunch Grass.

Poa Vaseyana, Scribn.

This fine species was found in abundance by Prof. Buffum, on the Big Sandy, July 1892. He sent it for determination to Dr. Beal, who pronounced it probably new. Whether specimens were later sent to the Department of Agriculture or the same had been collected by Dr. Vasey I am unable to say, but subsequently it received the above name.

Poa sp.

Of this, Dr. F. Lamson-Scribner writes: "I am not prepared to name it. It has some characters in common with *Poa occidentalis*, Vasey, but it is apparently distinct from that."

Glyceria arundinacea, Kunth.

On Spring Creek, Big Horn Mountains, August 5, 1892.

Glyceria grandis, Wats, Gray, Man. Ed. 6, 667 (1890). *Panicularia aquatica*, (L.) Kuntze.

Common in partially submerged meadow lands.

Big Horn Valley, July, 1892; Cummins, July 30, 1895 (No. 1534).

Glyceria pauciflora, Presl. Rel. Hænk. i, 257 (1830). *Panicularis pauciflora*, (Presl.) Kuntze.

Infrequent; Centennial Valley, August 18, 1895 (No. 1720).

Festuca confinis, Vasey.

Big Horn Mountains, August, 1892; Carbon county, June 11, 1892; Pole Creek June 2, 1894 (No. 161); Wallace Creek, July 29, 1894 (No. 667).

Festuca gracillima, Hook.

Big Sandy, Wind River Mountains, July, 1892.

Festuca ovina, L. Sp. Pl. 73 (1753).

From Laramie county, August, 1891.

Festuca ovina brevifolia, Chlor. Melv. 289 (1823).

Big Sandy, July, 1892.

Festuca rubra, L. Sp. Pl. 74 (1753).

Wind River Mountains, July, 1892.

Festuca tenella, Willd. Enum i, 113 (1809). *F. octoflora*, Walt. Fl. Car. 81.

Wheatland, 1892, by M. R. Johnson.

Bromus brevilaristatus, (Hook.) Buckl. Proc. Acad. Phila. 1862, 98 (1862).

Wolf Creek, July, 1892.

Bromus ciliatus, L. Sp. Pl. 76 (1753).

Inyan Kara Divide, August 30, 1892.

Bromus Hookerianus, Thurb.

Centennial Valley, September 7, 1891.

Bromus Kalmii occidentalis, Vasey.

Union Pass, August 11, 1894 (No. 821); Sand Creek, Fremont County, August 27, 1894 (No. 1105).

Bromus Pumpellianus, Scribn.

Big Wind River, July 1892.

Agropyrum caninum, R. & S. Syst. ii, 756 (1817).

Specimens in the World's Fair collection, 1892.

Agropyrum divergens, Nees. Steud. Syn. Gram. 347 (1855).

Frequent in the northern part of the state.

Lander, July 1892; Union Pass, August 11, 1894 (No. 820).

Agropyrum glaucum, R. & S. Syst. Veg. ii, 752 (1817). *A. repens glaucum*, (Desf.) Scribn.

One of the most valuable of the native hay grasses, producing heavy crops under judicious irrigation. It is essentially an upland grass and over-irrigation will soon destroy it.

Lander, July 1892; Laramie and other places at various times.

Agropyrum unilaterale, Cassidy, Bull. Col. Exp. Station xii, 63 (1890) *A. caninum unilaterale* (Cassidy) Vasey.

Sheridan, August 18, 1892.

Agropyrum violaceum, Vasey, Grasses U. S. Spec. Rep. No. 63, 45. A valuable forage plant; Big Sandy, July 1892.

Hordeum jubatum, L. Sp. Pl. 85 (1753).

The worst weed in the state; a positive pest in the hay fields. Its extermination should receive every encouragement.

Hartville, July 16, 1894 (No. 558), and noted in numerous places.

Hordeum nodosum, L. Sp. Pl. Ed. 2, 126 (1762).

Infrequent; Big Horn Mountains, August 4, 1892.

Hordeum pusillum, Nutt. Gen. i, 87 (1818).

Infrequent; Platte River, Fairbanks, July 11, 1894 (No. 426).

Elymus Canadensis, L. Sp. Pl. 83 (1753).

Frequent but hardly common; Whalen Canon, July 18, 1894 (No. 552), and by B. C. Buffum in 1892.

Elymus condensatus, Presl. Rel. Hænk. i, 265 (1830).

Common along streams in the eastern part of the state
Wheatland, 1892.

Elymus sitanion, Schult. Mant. ii, 426 (1824). *E. elymoides*, (Raf.) Swezey.

On mountain slopes at high altitudes.

Union Peak, August 13, 1894 (No. 1021); Laramie Peak, August 6, 1895 (No. 1602).

Elymus Virginicus, L. Sp. Pl. 84 (1753).

Not common; Prairie Dog, August 8, 1892.

CONIFERÆ.

Pinus flexilis, James, Long Exp. ii, 35 (1823).

This is common in our mountain ranges.

Laramie Hills, May 12, 1894 (No. 18); Cummins, July 29, 1895 (No. 1501). *Rocky Mountain White Pine*.

Pinus Murrayana, Balfour, Jeffr. Rep. Oreg. Exp. (1853).

Noted in the foothills in the Laramie and Medicine Bow ranges, where it is of frequent occurrence along streams.

Our specimens from Pole Creek, May 12, 1894 (No. 12); May 18, 1895 (No. 1213). *Lodge Pole Pine*.

Pinus ponderosa scopulorum, Engelm. Wats. Bot. Cal. ii, 126 (1880).

This forms a somewhat scattering growth on the higher more exposed ridges in the Laramie range, and less conspicuously so in the other ranges visited.

Laramie Hills, May 12, 1894 (No. 17). *Rocky Mountain Yellow Pine*.

Picea Engelmanni, Engelm.

This forms a considerable proportion of the forest growth in the Medicine Bow and probably in the other ranges of our state. Attaining its most luxuriant growth at about 9,000 ft., it is the sole survivor of the trees at timber line and there becomes reduced and spreading-prostrate. Said to be the most valuable of our trees for lumber.

Union Pass, August 13, 1894 (No. 1014); La Plata Mines, August 24, 1895 (No. 1841). *Engelmann's Spruce*.

Picea pungens, Engelm.

This is much less common and usually occurs along streams in the wooded foothills. It is considered the most beautiful of our Spruces and is well worthy of the high esteem in which it is held as an ornamental tree.

Laramie Hills, May 12, 1894 (No. 16); Cummins, July 30, 1895 (No. 1549). *Blue Spruce*. *Balsam*.

Pseudotsuga Douglasii, Carr.

The largest of our forest trees, attaining a remarkable size in the lower altitudes of our mountain ranges.

Laramie Hills, May 12, 1894 (No. 14); April 1895 (No. 1208); *Douglas Spruce*.

Juniperus communis, L. Sp. Pl. 1040 (1753).

Very rare; Cummins, July 28, 1895 (No. 1481).

Juniperus communis alpina, Gaud. Fl. Helv. vi, 301 (1830). *J. nana*, Willd.

This is abundant on hillsides at all altitudes.

Laramie Hills, May 4, 1894 (No. 11); Little Sandy, August 30,

1894 (No. 1128). *Prickly Juniper*.

Juniperus Sabina procumbens, Pursh, Fl. Am. Sept. 647 (1814).
J. Sabina, L.

Rare; observed only on the alpine summits of the Medicine Bow Mountains, La Plata, August 24, 1895 (No. 1834).

Juniperus Virginiana, L. Sp. Pl. 1039 (1753).

This is frequent, varying within our range from a prostrate, scraggly shrub to a large tree. Incorrectly called *Red Cedar*.

Laramie Hills, April 4, 1894 (No. 1). *Virginia Juniper*.

EQUISETACEÆ.

Equisetum arvense, L. Sp. Pl. 1061 (1753).

Frequent on water courses.

Pole Creek, May 25, 1894 (No. 77); July 2, 1895 (No. 1411).

Equisetum arvense alpestre, Wahl.

Not common; occurring usually on abrupt wet creek banks.

Big Wind River, August 5, 1894 (No. 706).

Equisetum hiemale, L. Sp. Pl. 1062 (1753).

Common on sandy river bottoms.

Laramie River, June 19, 1894 (No. 275); Laramie Peak, August 8, 1895 (No. 1640). *Scouring Rush*.

Equisetum lævigatum, A. Br. Engelm. Am. Journ. Sci. xlv, 87 (1844).

Infrequent; C. Y. Ranch on the Big Muddy, July 23, 1894 (No. 604).

Equisetum variegatum, Schleich. Cat. Pl. Helv. 27 (1807).

Fish Hatchery at Laramie, July 1891; Pole Creek, June 28, 1895 (No. 1355).

FILICES.

Asplenium Filix-fœmina, (L.) Bernh. Schrad. Neues. Journ. Bot. i, part 2, 26 (1806).

Infrequent; Jackson's Hole, August 21, 1894 (No. 940).

Oheilanthes lanuginosa, Nutt. Hook. Sp. Fil. ii, 99 (1858). *C. gracilis*, Mett.

In dry, rocky, cliffs; Laramie, 1891; Platte Canon, July 13, 1894 (No. 442).

Chryptogramma acrostichoides, R. Br. App. Frank. Journ. 767 (1823).

Teton Mountains, August 21, 1894 (No. 950).

Cystopteris fragilis, (L.) Bernh. Schrad. Neues. Journ. Bot. i, part 2, 27 (1806).

Common; Pole Creek, June 2, 1894 (No. 97); Mexican Mines, July 20, 1894 (No. 587).

Notholaena sinuata, Kaulf.

A specimen by B. C. Buffum, July 8, 1892; no other data.

Pteris aquilina, L. Sp. Pl. 1075 (1753).

Teton Mountains, August 21, 1894; Laramie Peak, August 6, 1895 (No. 1801).

Woodsia Oregana, Eaton, Can. Nat. ii, 90 (1865).

Centennial Hills, August 16, 1895 (No. 1682).

Woodsia scopulina, Eaton, l. c.

Much more frequent than the preceding; in crevices and on rocky ledges throughout our range.

Teton Mountains, August 21, 1894 (No. 951); Laramie Peak, August 6, 1895 (No. 1594).

SELAGINELLACEÆ.

Selaginella rupestris, Spring, in Mart. Fl. Bras. i, part 2, 118 (1840).

On a dry, naked ridge near table Mountain, June 28, 1895 (No. 1345).

MUSCI.*

Ceratodon purpureus, Brid. Bryol. Univ. i, 480 (1826).

Head of Pole Creek, May 18, 1895 (No. 1211 in part).

Desmatodon latifolius glacialis, Schimp. Syn. 157.

Nearly alpine; La Plata Mines, August 24, 1895 (No. 1835).

Desmatodon Porteri, James, Aust. Musc. Appal. n. 123.

Cummins, July 30, 1895 (No. 1538 in part).

Barbula mucronifolia, Bruch. & Schimp. Mon. xxxviii, t. 23 (1842).

Cummins July 30, 1895 (No. 1538 in part).

Philonotis fontana, Brid. Bryol. Univ. ii, 18 (1827).

Centennial Valley, August 18, 1895 (No. 1756); LaPlata Mines, August 22, 1895 (No. 1800).

Aulacomnium papillosum, Lesq. & James, Man. Moss. N. A. 253.

Centennial Valley, August 19, 1895 (No. 1746).

* The Musci were determined and arranged by Prof. J. M. Holzinger.

-
- Leptobryum pyriforme**, Schimp. Syn. Musc. Eur. 390 (1876).
Centennial Valley, August 18, 1895 (No. 1717).
- Webera albicans**, Schimp. Coroll. 67.
Pole Creek, near Table Mountain, July 1, 1895 (No. 1285).
- Webera elongata**, Schwægr. Spec. Musc. 48.
Centennial Valley; August 18, 1895 (No. 1723 in part).
- Webera** sp.
Specimens sterile, but different from the preceding.
Centennial Valley, August 19, 1895 (No. 1745).
- Bryum cœspiticium**, L. Sp. Pl. ii, 1121 (1753).
Head of Pole Creek, May 18, 1895 (No. 1211 in part).
- Bryum cirrhatum**, Hoppe & Hornsch. Fl. 90 (1819). var. ?
Cummins, July 30, 1895 (No. 1538 in part).
- Bryum intermedium**, Brid. Musc. Recent Suppl. iv, 120.
Centennial Valley, June 8, 1895 (No. 1263).
- Bryum pseudotriquetrum**, Schwægr. Suppl. i, 2, 110.
Centennial Valley, June 8, 1895 (No. 1259).
- Mnium subglobosum**, Bruch. & Schimp. Bryol. Eur. t, 388.
Centennial Valley, August 19, 1895 (No. 1744).
- Timmia Austriaca**, Hedw. Sp. Musc. 176, t. 42 (1801).
Laramie Peak, August 8, 1895 (No. 1645).
- Polytrichum juniperinum alpinum**, Schimp. Syn. 447.
La Plata Mines, August 24, 1895 (No. 1830).
- Polytrichum piliferum**, Schreb. Spicil. Fl. Lips. 74.
La Plata mines, August 21, 1895 (No. 1769).
- Olimacium Americanum**, Brid. Musc. Recent Suppl. ii, 45.
Centennial Valley, August 19, 1895 (No. 1724).
- Pseudoleskea oligoclada**, Vindb.
Centennial Valley, August 18, 1895 (No. 1734).
- Thuidium Blandovii**, Bruch. & Schimp. Bryol. Eur. t. 486.
Centennial Valley, August 19, 1895 (No. 1746 in part).
- Brachythecium acutum**, Sulliv. Icon Musc. Suppl. 99, t. 75.
Centennial Valley, August 17, 1895 (No. 1698).
- Brachythecium rivulare**, Bruch & Schimp. Bryol. Eur. t. 543.
Laramie Peak, August 7, 1895 (No. 1622).
- Hypnum commutatum**, Hedw. Musc. Frond. iv, 68, t. 24.
Gros Ventre River, August 16, 1894 (No. 1088).

Hypnum plicatile, Lesq. & James. Man. Moss. N. A. 394.

Cummins, July 29, 1895 (No. 1507).

MARCHANTIACEÆ.

Marchantia polymorpha, L.

Frequent on wet banks; Green River, August 25, 1894 (No. 1005).

Centennial Valley, August 18, 1895 (No. 1748).

ALGÆ.

The Algæ have received no attention so far as specific determination is concerned. In the collection of material for class use in the laboratory it has been found that quite a large number of genera are represented, some of them by a number of species. Among these *Spirogyra*, *Zygnema* and *Vaucheria* may be named. *Diatomaceæ* are everywhere but the *Desmidiaceæ* are not so well represented.

Among the larger forms the two following are conspicuous in the ponds at the city springs:

Chara foetida, A. Br.

It forms a dense growth over the bottom of the ponds, in places reaching a foot or more in height.

Batrachospermum gelatinosum, (L.) A. F. Woods, Rep. Bot. Surv.

Neb. iii, 6 (1894).

Adherent to stones in running water.

Chara sp.

A rather unusual *Chara* was collected in a pool in the mouth of an extinct geyser pan on Warm Spring Creek. It is in the hands of Mr. J. W. Blankinship for determination; August 9, 1894 (No. 796).

FUNGI.

The following Fungi have been determined by Mr. J. B. Ellis. They include only incidental "pickups" in the field. Those of economic importance that we have had to deal with on the Experiment Farm are not included.

Æcidium abundans, Pk.

Cummins, July 29, 1895 (No. 1498). On *Symphoricarpos microphilus*.

Æcidium monoicum, Pk.

Laramie Hills, May 23, 1894 (No. 50). On *Sisymbrium linifolium*.

Æcidium Oenothera, Mont.

Pole Creek, June 2, 1894 (No. 133). On *Oenothera brachycarpa*.

Uromyces Junci, (Schw.) Tul.

Laramie, December, 1895 (No. 1207). On *Juncus* sp.

Erysiphe cichoracearum, DC.

Cummins, July 29, 1895 (No. 1516). On *Hydrophyllum occidentale*.

Melampsora farinosa, (Pers.) Schrøet.

Cummins, July 29, 1895 (No. 1520); Centennial Valley, August 25, 1895 (No. 1864). Frequent on various *Willows*.

Phragmidium subcorticum, Schrank.

Cummins July 29, 1895 (No. 1499). On *Rosa blanda* (?).

Ramularia sidalcea, E. & E.

Cummins, July 29, 1895 (No. 1468). On *Sidalcea candida*. Mr. Ellis writes of this as follows; "I have seen it but once before. It was from British Columbia, sent by Dr. Macoun."

LICHENES.

The following are a few of our commoner *Lichens*:

Olaydonia pyxidata, Fr. Centennial Valley, August 18, 1895 (No. 1749).

Evernia vulpina, Ack. Centennial Hills, August 17, 1895 (No. 1699).

Parmelia conspersa, Ehrh. Pole Creek, July 1, 1895 (No. 1387).

Parmelia molliuscula, Ack. Laramie, July 23, 1895 (No. 1429).

Peltigera aphthosa, Hoffm. Laramie Peak, August 8, 1895 (No. 1644).

Peltigera canina, Hoffm. Cummins, July 29, 1895 (No. 1508).

Rinodina turfacea, Kærst. Centennial Hills, August 17, 1895 (No. 1713).

Appendix to List of Species.

***Arabis Drummondii**, Gray, Proc. Am. Acad. vi, 187.

On fertile hillsides in the mountains; not frequent.

Union Pass, August 10, 1894 (No. 875); Centennial Hills, June 7, 1895 (No. 1248).

Arabis hirsuta, (L.) Scop. Fl. Carn. Ed. 2, ii, 30 (1772).

In sandy valleys, sometimes among the sage brush; frequent.

Laramie Hills, June 7, 1894 (No. 181); Union Pass, August 13, 1894 (No. 1074); Pole Creek, July 1, 1895 (No. 1394).

Arabis Holboellii, Hornem. Fl. Dan. t. 1879 (1827).

On a dry, stony sandbar of the Laramie River, Cummins, July 30, 1895 (No. 1551).

Arabis Holboellii Fendleri, Wats. Syn. Fl. i, 164 (1895).

Noted only in the sand beds of the stony foothills of the Laramie range; May 16, 1894 (No. 32).

Arabis Lemmoni, Wats. Proc. Am. Acad. xxii, 467 (1887).

Among the sage brush on the plains; infrequent.

Laramie, May, 23, 1894 (No. 56).

Arabis Lyalli, Watson, Proc. Am. Acad. xi, 122.

Alpine; Teton Mountains, August 21, 1894 (No. 1007).

Arabis Nuttallii, Robinson, Syn. Fl. i, 160 (1895).

In valleys but on dry ground.

Horse Creek, June 9, 1894 (No. 218); Pole Creek, June 28, 1895 (No. 1359).

Arabis perfoliata, Lam. Encycl. i, 219 (1788).

Rare; noted but once; Laramie Peak, August 7, 1895 (No. 1628).

Thelypodium integrifolium, Endl. in Walp. Rep. i, 172 (1842).

Very frequent, especially on saline plains.

Lusk, July 21, 1894 (No. 574); Dubois, August 9, 1894 (No. 747); Laramie, August 10, 1895 (No. 1663).

* Determinations in this genus by Dr. B. L. Robinson.

Thelypodium sagittatum, Endl. l. c.

Widely distributed, but only scattering plants.

Wheatland, June 18, 1891 ; Pole Creek, June 2, 1894 (No. 112);
Bacon Creek, August 15, 1894 (No. 922).

Sisymbrium virgatum, Nutt. in T. & G. Fl. i, 93.

On sandy ground among the sage brush.

Laramie Plains, June 9, 1895 (No. 1299).

Draba nemorosa, L. Sp. Pl. 643 (1753).

Frequent in wet loam soil in valleys ; variable, some of our specimens are the variety *hebecarpa*, Lindb.

Pole Creek, June 2, 1894 (No. 153); Union Pass, August 11, 1894 (No. 854); Centennial Valley, June 9, 1895 (No. 1254); at other times and places.

Arenaria Nuttallii, Pax in Engler, Jahresb. xviii, 30.

Infrequent ; noted only at Garfield Peak, July 29, 1894 (No. 675).

Astragalus bodini, Sheld.

Very abundant in meadow lands in the Centennial Valley ; August 25, 1895 (No. 1855).

Astragalus leucopis, Torr. Mex. Bound. Surv. 56, t. 16.

Rare ; specimens from the eastern part of the state by B. C. Bufum in 1892.

Astragalus Parryi, Gray, Am. Journ. Sci. ii, 33.

Frequent on gravelly hillsides ; Pole Creek, June 2, 1894 (No. 101); Centennial Valley, June 9, 1895 (No. 1298).

CORRECTIONS:—

On page 63, line 3 from bottom, read Engelmann's Spruce for Douglas Spruce.

In the *Astragali* some of the names as given in the list of *Pteridophyta* and *Spermaphyta*, which it was intended to give as synonyms, were inadvertently omitted.

New Species and Varieties.

The succeeding list includes the new species, varieties and names as published in this report.

	PAGE.
<i>Aquilegia cærulea alpina</i> , n. var.	78
<i>Aquilegia Laramiensis</i> , n. sp.	78
<i>Aconitum Columbianum ochroleucum</i> , n. var.	79
<i>Thlaspi alpestre glaucum</i> , n. var.	84
<i>Trifolium longipes reflexum</i> , n. var.	94
<i>Oxytropis Lamberti ochroleuca</i> , n. var.	98
<i>Potentilla pinnatisecta</i> , n. sp.	104
<i>Erigeron uniflorus melanocephalus</i> , n. var.	131
<i>Hymenopappus ligulæflorus</i> , n. sp.	135
<i>Actinella glabra</i> , (Nutt.)	136
<i>Artemisia Ludoviciana integrifolia</i> , n. var.	138
<i>Senecio Douglasii</i> , (Some forms of)	141
<i>Senecio lugens megalcephalus</i> , n. var.	142
<i>Hieracium gracile minimum</i> , n. var.	144
<i>Androsace septentrionalis subumbellata</i> , n. var.	149
<i>Mertensia lanceolata viridis</i> , n. var.	158

The following have recently been published as new from this state:

<i>Ranunculus eximus</i> , Greene.	77
<i>Tissa sparsiflora</i> , Greene.	88
<i>Amelanchier pumila</i> , (Nutt.) Greene.	106
<i>Mitella trifida integripetala</i> , Rose.	107
<i>Mentzelia Nelsonii</i> , Greene.	113
<i>Chrysothamnus collinus</i> , Greene, Pitt. iii, part 13, 24 (1896).	122
<i>Chrysothamnus linifolius</i> , Greene, l. c.	123
<i>Allocarya Nelsonii</i> , Greene.	156
<i>Eriogonum subalpinum</i> , Greene, Pitt. iii, part 13, 18 (1896).	174

Lists of Plants Reported by Other Collectors.

In the succeeding lists such plants are given as have been reported by others from this state but are as yet unrepresented in our herbarium. It is intended to exclude all names that are merely synonyms of those of our own list, but even with greatest care I fear some will get in. Some, while not synonyms, are names of plants that very doubtfully belong to this region at all. On the other hand these lists, undoubtedly, do not represent all that have been reported from this state, but are intended to be complete with respect to the literature at hand. Such references as could not somewhat satisfactorily be verified are excluded, probably too many.

FROM TORREY'S REPORT ON THE PLANTS OF FREMONT'S EXPEDITION, 1842.

Astragalus tridactylus, Gray, as *Phaca digitata*, Torr. Little Sandy, August 8.

Potentilla Pennsylvanica glabrata, Watson, as *P. sericea glabrata*, Lehm. Sweetwater River, August 4-15.

Sedum rhodiola, DC. Wind River Mountains, August 12-17.

Symphoricarpos vulgaris, Michx. Wind River Mountains, August 13-14.

Aster Novæ-Angliæ, L. Wind River Mountains, August 18.

Aster andinus, Nutt. Wind River Mountains, August 16.

Erigeron salsuginosus glacialis, Gray, as *Aster glacialis*, Nutt. Wind River Mountains, August 16.

Solidago nemoralis incana, Gray, as *S. incana*, T. & G. Sweetwater River.

Helianthus petiolaris, Nutt. Laramie Hills, July 26.

Helianthus Maximiliana, Schrader. Laramie Hills, July 26.

Hymenopappus corymbosus, T. & G. Upper Platte, August 26.

Vaccinum myrtilloides, Hook. Wind River Mountains, August 15.

Dodecatheon Meadia latilobum, Gray, as *D. dentatum*, Hook., Wind River Mountains, August 13-16.

Phlox muscoides, Nutt. Wind River Mountains, August 15.

Gentiana arctophila, Griseb. Sweetwater River, August 4.

Gentiana linearis, Frœl. as *G. pneumonanthe*, L. Laramie River, July 12.

Habenaria leucophæa, Gray, as *Plantanthera leucophæa*, Lindl. Laramie (Black) Hills, July 27.

Spiranthes cernua, Rich. Sweetwater River, August 6.

**FROM COULTER'S REPORT ON THE BOTANY OF THE
HAYDEN SURVEY, 1872.**

Clematis alpina occidentalis, Gray, Teton Mountains, July.

Ranunculus Nelsonii, Gray, Yellowstone Lake.

Aquilegia flavescens, Wats. Yellowstone Lake, August.

Delphinium Menziesii, DC. Teton Mountains, July.

Aconitum Fischeri, Wats. as *A. nasutum*, Hook. Yellowstone Lake, August.

Nuphar advena, Ait. Yellowstone Park, August.

Dicentra uniflora, Kellogg. Teton Mountains, August.

Cardamine oligosperma, Nutt. Teton Mountains, July.

Draba aurea, Vahl. Teton Mountains, July.

Draba nivalis, Lilj. as *D. Stellata*, Jacq. Teton Mountains, July.

Lychnis Drummondii, Wats. Yellowstone Park, July.

Arenaria pungens, Nutt. Teton Mountains, July.

Arenaria verna, L. Teton Mountains, July.

Arenaria laterifolia, L. Teton Mountains, July.

Sagina Linnæi, Presl. Yellowstone Park, August.

Claytonia linearis, Hook. Clark's Fork, August.

Spraguea umbellata, Torr. Yellowstone Park, August.

Dryas octopetala, L. Teton Mountains, July.

Ivesia Gordonii, Gray, Teton Mountains, July.

Saxifraga oppositifolia, L. Teton Mountains, July.

Tellima parviflora, Hook. Teton Canon, Wyo. (?), July.

Heuchera cylindrica, Dougl. Yellowstone Park, August.

Ribes bracteosum, Dougl. Teton Canon, Wyo. (?) August.

Sedum rhodiola, DC. Teton Mountains, July.

Linnæa borealis, Gronov. Yellowstone Park, August.

Townsendia scapigera Eaton, Teton Mountains, July (?).

Solidago serotina, Ait. as *S. gigantea*, Ait. Yellowstone Park, August (?).

Rudbeckia occidentalis, Nutt. Teton Mountains, July.

Crepis Andersoni, Gray, Yellowstone Park, August.

Crepis nana, Richards, Teton Mountains, July.

Vaccinum ovafolium, Smith, Upper Teton Canon, July.
Ledum glandulosum, Nutt. Shoshone Lake, September.
Pentstemon Menziesii, Hook. Teton Mountains, August (?).
Mimulus nanus, H. & A. as *Eunanus Fremonti*, Gray, Crater Hills, August.
Synthyris alpina, Gray, Teton Mountains, July.
Orthocarpus Tolmiei, H. & A. Fort Bridger, by Dr. Leidy.
Lycopus Virginicus, L. Yellowstone Park, August.
Hydrophyllum capitatum alpinum, Wats. Teton Mountains, July.
Nemophila parviflora, Dougl. Yellowstone, July.
Phlox canescens, T. & G. Teton Mountains, July.
Gilia intertexta, Steud. Teton Mountains, August.
Polemonium foliossimum, Gray, Yellowstone Lake, August.
Kochia prostrata, Shrad. Fort Bridger, by Dr. Leidy.
Erigonum salsuginosum, Hook. Fort Bridger, by Dr. Leidy.
Salix reticulata, L. Teton Mountains, July.
Pinus contorta Dougl. Yellowstone Park, August.
Abies Subalpina, Eng. as *A. grandis*, Trail River Mountains, August.
Lemma triscula, L. Yellowstone Park, August.
Zannichellia palustris, L. Yellowstone Lake, 1871.
Goodyera Menziesii, Lindl. Teton Mountains, September.
Corallorhiza mutiflora, Nutt. Shoshone Lake, September.
Lloydia serotina, Reich. Teton Mountains and Clark's Fork, July.
Carex rigida, Good. Red Mountain, September.
Carex alpina, Swartz. Uinta Mountains, by Dr. Leidy.
Calamagrostis sylvatica, DC. Teton Mountains. August.
Spartina gracilis, Trin. Yellowstone Park, August.
Pellaea Breweri, Eaton Teton range, August.
Pellaea densa, Hook. Jackson's Lake, September.
Aspidium Lonchitis, Swartz. Teton Mountains, July.
Aspidium spinulosum, Swartz. Teton Mountains, September.

**FROM PARRY'S REPORT ON THE BOTANY OF JONES'S
EXPEDITION IN NORTHWESTERN WYOMING, 1873.**

Aquilegia flavescens, Wats. Yellowstone Park, August.
Aquilegia Jonesii, Parry, Owl Creek range, July.
Delphinium Menziesii, DC. Fort Bridger, June.

- Ranunculus occidentalis, Nutt. Little Sandy, June.
Myosurus minimus, L. Snake River, September.
Thalictrum alpinum, L. Wind River range, July.
Stanleya tomentosa, Parry, Owl Creek, July.
Draba ventosa, Snake River Pass, September.
Arabis canescens, Nutt. Sweetwater, June.
Lesquerella (*Vesicaria*) alpina, Nutt. Green River, June.
Capsella divaricata, Walp. Little Sandy, June.
Nasturtium curvisiliqua lyratum, Wats. Yellowstone, August.
Subularia aquatica, Yellowstone Lake, August.
Arenaria Franklinii, Dougl. Wind River, July.
Arenaria pungens, Nutt. Stinkingwater, July.
Arenaria stricta, Wats as *A. Rossii*, R. Br. Owl Creek range, July.
Arenaria arctica, Stev. Owl Creek, July.
Lychnis Drummondii, Wats. Owl Creek, July.
Lychnis Kingii, Wats. as *L. Ajanensis*, Regel. Owl Creek range, July.
Spraguea umbellata, Torr. Stinkingwater, August.
Calyptridium roseum, Wats. Green River, June.
Rhamnus alnifolia, L'Her. Stinkingwater, August.
Lupinus minimus, Dougl. Stinkingwater, August.
Trifolium andinum, Nutt. Ham's Fork, June.
Astragalus ventorum, Gray, Wind River, July.
Astragalus triphyllus, Pursh, Owl Creek, July.
Astragalus simplicifolius, Gray, Green River, June.
Astragalus glabriusculus, Gray, Wind River, July.
Astragalus lotiflorus, Hook. Wind River, July.
Astragalus Geyeri, Gray, Green River, June.
Astragalus flavus, Nutt. Green River, June.
Astragalus pubentissimus, Nutt. Green River, June.
Astragalus glareosus, Dougl. Green River, June.
Astragalus microcystis, Gray, Stinkingwater, July.
Oxytropis campestris, L. Owl Creek, July.
Oxytropis viscida, Nutt. Wind River, July.
Oxytropis lagopus, Nutt. Pacific Springs, June.
Spirea caespitosa, Nutt. Owl Creek range, July.
Ivesia Gordoni, Gray, Stinkingwater, July.
Heuchera cylindrica Dougl. Stinkingwater, July.
Saxifraga debilis, Engelm. Owl Creek range, July.

Ribes viscosissimum, Pursh, Yellowstone, August.
Ribes bracteosum, Dougl. Wind River, July.
Oenothera andina, Nutt. Green River, June.
Oenothera scapoidea, Nutt. Green River, June.
Zauschneria Californica, Pressl. Stinkingwater, July.
Peucedanum leiocarpum, Nutt. Yellowstone, August.
Cymopterus Fendleri, Gray, Green River, June.
Lonicera cærulea, L. Yellowstone, August.
Kelloggia galeoides, Torr. Stinkingwater, August.
Erigeron coccinnus, Gray, Green River, June.
Townsendia spathulata, Nutt. Wind River, July.
Townsendia Watsoni, Gray, as *T. strigosa*, Nutt. Wind River, July.
Townsendia Parryi, Eaton. Wind River, July.
Townsendia condensata, Parry, Washakie's Needles, July.
Bahia (*Schkuhria*) *integrifolia*, Parry, Wind River Mountains, July.
Rudbeckia occidentalis, Nutt. Snake River, September.
Arnica Parryi, Gray, Yellowstone, August.
Aplopappus suffruticosus, Gray, Yellowstone, August.
Aplopappus multicaulis, Gray, Wind River, July.
Balsamorhiza Hookeri, Nutt. Pacific Springs, June.
Antennaria dimorpha, Nutt. Green River, June.
Antennaria luzuloides, T. & G. Stinkingwater, July.
Tanacetum Nuttallii, T. & G. Wind River, July.
Artemisia pedatifida, Nutt. Green River, June.
Artemisia spinescens, Eaton, Green River, June.
Artemisia discolor incompta, Gray, Owl Creek, July.
Troximon glaucum parviflorum, Gray, Green River, June.
Stephanomeria paniculata, Nutt. Stinkingwater, July.
Crepis occidentalis, Nutt. Wind River, July.
Laurentia (*Porterella*) *carnosula*, Benth. Yellowstone, August.
Ledum glandulosum, Nutt. Yellowstone, August.
Gaultheria Myrsinites, Hook, Yellowstone, August.
Pyrola picta, Smith, as *P. dentata*, Hook. Yellowstone, August.
Androsace Chamæjasme, L. Owl Creek, July.
Douglasia montana, Gray, Owl Creek Mountains, July.
Pentstemon Menziesii, Hook, Stinkingwater, August.
Mimulus nanus. H. & A. as *Eunanus Fremontii*, Gray, Yellowstone, August.

Castilleja breviflora, Gray, Stinkingwater, July.
Gilia pungens, Benth. Green River, June.
Gilia iberidifolia, Benth. Green River September.
Asclepias brachystephana, Torr. Green River, June.
Polygonum imbricatum, Nutt. Stinkingwater, July.
Oxytheca dendroidea, Nutt. Big Sandy, June.
Atriplex endolepis, Watson, Stinkingwater, July.
Grayia polygaloides, H. & A. Green River, June.
Carex aquatilis, Wahl. Yellowstone, August.
Carex rigida, Good. Yellowstone, August.
Carex Hoodii, Boot. Wind River, July.
Carex tenuirostris, Olney, Yellowstone, July.
Isœtes Bolanderi, Engelm. Yellowstone, August.

FROM GRAY'S REPORT ON THE PLANTS OF THE JENNEY SURVEY OF THE BLACK HILLS, 1875.*

<i>Clematis alpina occidentalis</i> , Gray.	<i>Cornus Canadensis</i> , L.
<i>Thalictrum dioicum</i> , L.	<i>Aster falcatus</i> , Lindl.
<i>Aconitum Fischeri</i> , Reichenb.	<i>Solidago speciosa angustata</i> , T. & G.
<i>Lesquerella (Vesicaria) alpina</i> , Nutt.	<i>Echinacea angustifolia</i> , DC.
<i>Viola delphinifolia</i> , Nutt.	<i>Helianthus strumosus</i> , L.
<i>Helianthemum Canadense</i> , Michx.	<i>Helianthus petiolaris</i> , Nutt.
<i>Polygala alba</i> , Nutt.	<i>Pentstemon grandiflorus</i> , Nutt.
<i>Psoralea esculenta</i> , Pursh.	<i>Pentstemon albidus</i> , Nutt.
<i>Astragalus gracilis</i> , Nutt.	<i>Verbena bipinnatifida</i> , Nutt.
<i>Astragalus simplicifolius</i> , Gray.	<i>Lophanthus anisatus</i> , Benth.
<i>Lathyrus ochroleucus</i> , Hook.	<i>Mertensia oblongifolia</i> (Nutt.) Don.
<i>Sophora sericea</i> , Nutt.	<i>Eriogonum multiceps</i> , Nees.
<i>Geum rivale</i> , L.	<i>Lilium Philadelphicum</i> , L.
<i>Rubus triflorus</i> , Richard.	<i>Prosartes lanuginosa</i> , Don.
<i>Oenothera pumila</i> , L.	<i>Pellaea atropurpurea</i> , Link.
<i>Thaspium trifoliatum</i> , Gray.	<i>Onoclea sensibilis</i> , L.
<i>Cymopterus glomeratus</i> , Nutt.	

* Although the Black Hills are largely in Dakota, yet as the route of the party to and from them lay in this state, and as the flora of the Hills may reasonably be supposed to be approximately the same in both states, these names are included here.

SUMMARY.

In the foregoing lists there have been enumerated from the material in this herbarium 1118 species and varieties of *Phanerogams* (*Spermatophytes*), representing 393 genera. Omitting duplicates from the lists of plants reported by others there are enumerated 177 more, making a total of 1295 thus far reported from this state. This number, undoubtedly, does not do justice to all the work that has been done in the state and falls far short of the number that may be expected when it shall have been thoroughly worked. The northeast and southwest floras are quite distinct from each other and from those portions of the state which have been the most carefully examined. These are yet to be secured.

By way of comparison it may be stated that the following are among the best worked states and the number of species and varieties of *Phanerogams* reported are for Nebraska about 1460, and for West Virginia 1309.

Concerning the *Cryptogams* it may be said that they represent largely an unexplored field. Only 65 species are enumerated in this list, making the total number from this collection 1176 and for the state according to this list 1360. This does not include the Mosses and Lichens of the Hayden report, and possibly other collections may have been omitted.

Duplicates of a large part of the plants enumerated from this collection will be found in the herbaria of Harvard University, Columbia University, Shaw Botanic Garden, National Herbarium, the Vanderbilt collections at Biltmore, N. C., University of Minnesota, Cornell University, and Prof. E. L. Greene's Herbarium.

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UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

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ALKALI:

SOME OBSERVATIONS AND EXPERIMENTS.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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ALKALI:

SOME OBSERVATIONS AND EXPERIMENTS.

B. C. BUFFUM.

The presence in the soil of what is popularly known as alkali is almost universal in Wyoming. In some places the deposits in alkali lakes are of sufficient magnitude to be commercially important as sources of supply of salts of sodium and magnesium. In some parts large areas are known as alkali deserts owing to the low annual rainfall and the presence on the surface of quantities of these salts. The names of many of our streams as "Bad Water", "Poison Creek", "Alkali Creek", "Salt Creek", etc. indicate the presence of alkali, which finds its way into the country drainage from the soil. In some of our best farming districts larger areas are taken each year by the alkali, due to the accumulation of the salts on the surface, being brought from below by the water which evaporates leaving the alkali behind. This condition might be expected upon all of our irrigated farms, but we have some notable exceptions. In the Wheatland district, although the rainfall is too small to produce crops, and all farms are irrigated, no injurious alkali has appeared upon any of the uplands under cultivation.* The soil of the uplands here is colluvial and derived from the earlier geological formation† which do not supply the alkali salts.

*Water used for irrigation at Wheatland comes from the Laramie river and contains enough alkali to deposit large amounts on the land,—see Bul. No. 24 of the Wyo. Sta. Page 117,—on this account alkali will probably appear in places upon these lands in the course of a few years.

†Wyoming Station Bulletin No. 14, pp. 116 and 117.

Other parts of the state in which there is not sufficient alkali to be injurious are the northeastern portion where the annual rainfall is over fifteen inches, the mountains upon which the rainfall is large and the drainage good, and small valleys along streams in or near the mountains, where either the geological formation explains the absence of salts or the alkali has been leached from the soil by the abundance of water in the presence of good drainage, conditions which usually prevail in such places.

The reclamation of alkali lands and the prevention of the alkali taking possession of portions of our irrigated farms along with the effects of these salts upon soil and crops are the problems under consideration, the solving of which is of growing importance. It is upon the farms which are already under cultivation and valuable and those that may become affected that the question of what to do for the alkali is of paramount importance. Farmers cannot afford to have even small portions of their land become partially or entirely unproductive. Farms upon which no alkali is apparent at first, through irrigation, lack of proper drainage, and, perhaps, poor cultivation have given up continually larger areas as waste land, through the salts, which were at first distributed through the soil mass, coming to the surface. The low places where the largest amounts of water accumulate are the first to suffer. Portions of the Laramie and Sheridan Experiment Farms have become barren or unproductive through the rise of alkali. Upon the Laramie Farm the land which shows the most alkali now, produced good crops the first two years of cultivation.

Soils which contain large amounts of injurious salts are generally unusually rich in potash and phosphorus

which are plant foods and will render such land lastingly productive if the injurious salts can be eliminated. This fact has been clearly pointed out by Professor E. W. Hilgard, of the California Station, in his writings upon the subject.

KINDS OF ALKALI.

Alkali, as it occurs in the arid region, consists of one or more salts of sodium or magnesium as the principal ingredient. There are two general forms or classes known as "Black Alkali," and "White Alkali." The difference depends upon the presence or absence of carbonate of soda which forms the black alkali. Large amounts of sodium carbonate occur in the southwestern portion of the state along Green River, and in the central portion north of the Rattlesnake range of mountains. However, upon the greater part of our cultivated agricultural land, white alkali (consisting principally of sulfate) predominates. Hilgard has shown that the presence of alkali in soils is due to climatic conditions, and that the sulfate usually occurs in cold climates, while the carbonate, if formed naturally in the soil from other salts, generally occurs in warm climates, though he cites instances where the carbonate is left in the soil from the decomposition of rocks containing it.* This corresponds with the general conditions in Wyoming—great deposits of sodium sulfate, sodium carbonate and magnesium sulfate have been formed through geological agencies, but the carbonate does not form naturally from other salts in the soil and consequently its occurrence is local rather than general.

*Bulletin No. 3 of the U. S. Department of Meteorology on "Relations of Soil to Climate, and Year Book of Department of Agriculture for 1895.

The white alkali varies greatly in composition. In places it consists of pure sulfate of sodium (Glauber salt), in other localities pure sulfate of magnesium (Epsom salt) is found. Generally white alkali consists of sulfates of sodium and magnesium associated with smaller amounts of sodium chlorid (common salt), potassium chlorid, and calcium sulfate (gypsum). In the same place the composition does not seem to be constant, but varies at different times. The following analyses give the composition of alkali on the Laramie and Sheridan Experiment farms so far as data are available. The first four analyses are computed from water analyses made by Prof. Slosson and reported in Bulletin No. 24 of this Station. The amount of each salt of the alkali and the gypsum is given in per cent of the total alkali, no account being taken of the insoluble matter, silica, iron and alumina and calcium carbonate. The calcium sulfate is reported with the alkali as it is usually present and may account for the absence of black alkali, especially in No. 1, where the salts in the water that ran on the land contained $27\frac{3}{4}$ per cent carbonate of soda but no gypsum, while the waste water contained 23 per cent gypsum but no carbonate. The sodium carbonate is probably converted into the sulfate as fast as it comes to the soil with the irrigation water.

No. 1.—*Composition of Alkali in Waste Water from Irrigation of July 19, 1894, Laramie Farm. Wyoming Station Bulletin No. 24, page 111.*

Potassium chlorid K Cl.....	4.247
Sodium chlorid Na Cl.....	16.681
Sodium sulfate Na ₂ So ₄	54.684
Magnesium sulfate Mg So ₄	1.318
Calcium sulfate Ca So ₄	23.073

No. 2.—*Composition of Alkali in Waste Water, Irrigation of October 2, 1895, Laramie Farm. Wyoming Station Bulletin No. 24, page 113.*

Potassium chlorid K Cl.....	12.358
Sodium chlorid Na Cl.....	1.976
Sodium sulfate Na ₂ So ₄	39.722
Magnesium sulfate Mg So ₄ ..	42.371
Calcium sulfate Ca So ₄	3.573

No. 3.—*Composition of Alkali in Irrigation Water from Little Goose Creek used upon the Sheridan Experiment Farm. Taken September 15, 1893. Wyoming Station Bulletin No. 24, page 118.*

Potassium chlorid K Cl... ..	9.456
Sodium chlorid Na Cl.....	9.310
Sodium sulfate Na ₂ So ₄	39.430
Magnesium sulfate Mg So ₄	41.804

No. 4.—*Composition of Alkali in Well Water on the Sheridan Experiment Farm. Wyoming Station Bulletin No. 24, page 129.*

Potassium chlorid K Cl.....	.997
Sodium chlorid Na Cl.....	.145
Sodium sulfate Na ₂ So ₄	17.021
Magnesium sulfate Mg So ₄	42.736
Calcium sulfate Ca So ₄	39.100

No. 5.—*Composition of Alkali Extracted from Soil on the Laramie Farm Containing 2.24 per cent Salts within Two Inches of the Surface. Sample taken Dec. 4, 1895. Analysis made by W. H. Fairfield.*

Sodium and Potassium chlorids.....	14.39
Sodium sulfate Na ₂ So ₄	50.16
Magnesium sulfate Mg So ₄	20.03
Calcium sulfate Ca So ₄	15.41

AMOUNTS OF ALKALI THAT ARE INJURIOUS.

The amount of alkali in the soil that is injurious to crops depends upon its composition, the character of the soil, whether the salts are upon the surface, and the kind of crop grown. Prof. Hilgard states that less than one-tenth of one per cent of black alkali in a clay soil will

render it unproductive.* In the Year Book of the U. S. Department of Agriculture, page 116, he states that, "For the sandy loam of the Tulare Station, the maximum for cereals may be approximately stated to be one-tenth of one per cent for sal soda (black alkali), one-fourth of one per cent for common salt and from forty-five to fifty one hundredths of one per cent for Glauber salt within the first foot from the surface." This shows the sulphate to be the least injurious of the salts of sodium. Further experiments will be necessary to determine the effects of magnesium sulfate in our soils. Our experiments below show that some of the cereals will resist the effects of alkali better than others. For reasons hereafter stated it is doubtful if any of the cereals will produce a profitable crop on soil containing more than one per cent of alkali within the first two inches of the surface. Such land however will produce sugar beets and other crops which thrive in saline soils. So far as our experiments have progressed no crops have been found which will produce profitable returns upon land containing over two per cent of alkali within the first two inches of the surface. Such an amount produces a thin incrustation of the effervescent salts on the surface which only disappears for a few days at a time when the rains carry it into the soil, reappearing again as soon as the surface soil becomes dry.

LINES OF INVESTIGATION.

Our work with alkali naturally falls into the following classification:

2. The prevalence of alkali in the soil and its effect upon soil and vegetation.

*Annual Report, California Experiment Station for 1892, 1893 and part of 1894, page 149.

2. Effect of irrigation upon alkali soils.

3. Reclamation of such soils: (a)—By removing the alkali by leaching, growing plants which will take it up and removing the salts with the crop, or, removing the salts by mechanical or other means. (b)—By growing useful plants which will thrive and make such soils profitable. (c)—Prevention of the accumulation of alkali salts on the surface by proper cultivation, mulching or shading to prevent surface evaporation.

Farmers frequently inquire whether there is some substance which can be added to the soil to counteract the alkali. Converting the white alkali into a less harmful form or counteracting its effect in the soil by the use of other chemical agents seem such a hopeless task that no direct experiments of the kind have been attempted. In California where small per cents of the black alkali occur it may be converted into the white alkali by the use of gypsum or land plaster, the small amount of sulfate being less injurious than the carbonate, the land again becomes productive.

EFFECTS OF ALKALI.

On the Soil.—No attempt will be made to discuss the chemical effects of salts in the soil. Only a general statement of conclusions drawn from our observations and notes can be made here. Sodium carbonate has a much greater puddling effect upon the soil, destroying its tilth, as well as being more corrosive to plant tissues than the other alkali salts.

The water percolating through the soil seeks the lowest land, larger amounts of it are evaporated from the surface in these low places and consequently they are the

first to become unproductive. These salts hold water with more tenacity than do the loose soil particles, and the alkali soil is usually moist long after the surrounding soil is dry. Hilgard states that the white alkali has no puddling effect upon the soil. However I have observed that in low places where the alkali water stands for considerable periods of time the air is driven out of the soil and it loses its flocculation and tilth. Where the water stands in these low places it is often of a deep reddish color, probably owing to humus or humates of the soil being held in solution.

Upon the Laramie Plains in the open and irrigated grass lands occur spots of sandy or gravelly soil from a few feet to several rods in diameter, forming knolls a few inches higher than the surrounding land. These are devoid of grass or other vegetation. When dry weather prevails white incrustations of salts appear upon them. They seem to be natural reservoirs of soil moisture from which evaporation is unimpeded. They are mentioned here as an example of the effects of alkali on different kinds of soil. When these alkali spots are irrigated and properly cultivated to prevent evaporation and reverse the direction of the water movement, letting it drain from beneath, the alkali disappears and all the land becomes productive.

The white alkali does not change the physical condition of the soil to such an extent that it cannot be easily brought into a good state of tilth after the elimination of the noxious salts.

Effects Upon Vegetation.—The presence of such salts seems to affect plants in two ways. Prof. Hilgard says, "The injury to vegetation is caused mainly or wholly

within a few inches of the surface by the corrosion of the bark, usually near the root crown." He points out also that this corrosive effect is not so marked with the white alkali.

While white alkali corrodes plants at or near the surface, our experiments indicate that this corrosion is not the most important injury, especially to field crops which are grown from the seed in alkali soil. The greatest injury is due to the presence of the alkali interfering with the life functions, absorption and probably also assimilation, in the plant economy. A study of our germination tests and pot experiments point unmistakably to such a physiological effect, from, and even before the germination of the seed, to maturity. In small amounts this growth is merely retarded, while in the presence of larger amounts of salts the growth is entirely stopped or the life destroyed.

Effects Upon Seed Germination.—The requisites for the germination of seeds are heat, moisture and air. However, if the seeds be brought in contact with certain salts in the soil germination will be retarded or entirely prevented. The effects of salts in the soil upon seeds and their germination have been studied but little. The only investigations of this kind that have come to my notice are the observations of Hilgard and a small germinating test in the presence of alkali by Mr. C. Colemore, of San Francisco,* and some brief tests with other salts in France last year.†

THE ALKALI EXPERIMENTS.

Germination Test.—Notes upon the Laramie Farm for several years showed a marked slowness of germina-

*Report of the California Experiment Station for 1892, 1893 and part of 1894, page 141.

†Literary Digest of April 11, 1896, page (707) 17.

tion of crops planted on the lower or east side of the farm where alkali has come to the surface. In the spring of 1893 some garden seeds were planted in flats in the house. A part of the soil used was leaf mold from the mountains and a part ordinary soil from the farm containing small amounts of salts though not enough to prevent crops growing. Seeds of varieties of celery planted in the soil containing small amounts of alkali were several days longer coming up than those in the leaf mold. These observations led us to plan an experiment upon seed germination in the presence of alkali. Thanks are due Prof. Slosson and others in helping to plan and carry out the following experiments as well as to W. H. Fairfield, who did a large part of the work.

In order to know and control all conditions of soil, heat, moisture, etc., this work was carried on in the greenhouse. The condition of the soil was made the same, as nearly as possible, as would occur naturally in the field. The soil plats consisted of grāniteware pie plates containing 300 grams of soil. The soil for the experiment was taken from acre plat 11 on the Laramie Farm. The surface was covered with a white incrustation of alkali and supported no vegetation excepting a few weeds belonging to the *Chenopodiaceæ*. The top soil was taken to a depth of two inches which is about the depth of shallow planting of grasses and alfalfa. This was carefully mixed and an average sample taken for analysis. The analysis made by my assistant, W. H. Fairfield, gave 2.24 per cent soluble salts composed of 14.39 per cent sodium and potassium chlorids, 50.16 per cent sodium sulfate, 20.03 per cent magnesium sulfate and 15.41 calcium sulfate.

A part of the soil was placed in a large receptacle and washed for a number of days with distilled water until no reaction could be obtained for sulfates or chlorids except a small amount of gypsum which occurs naturally in the soil and dissolves so slowly that traces would remain after long leaching. The soil so treated was air-dried, passed through a one millimeter sieve and the moisture in this air-dried soil determined. It contained 2.7 per cent moisture.

After putting the soil into the plates they were covered with sheets of glass to prevent further evaporation. The different per cents of alkali were added to the requisite number of plates. This alkali was made up according to the analysis of the alkali extracted from the same soil and added to the plates in solution. Enough water was added in each case to make the per cent of moisture the same in each, so the soil would contain 25 per cent of moisture when the seeds were planted. The soil in each plate was covered with filter paper nearly the size of the plates. The seeds for the test were all selected under a dissecting microscope magnifying eight diameters. Six thousand seeds were examined in this way and the seeds so selected were as uniform as it was possible to obtain. In some cases one hundred per cent of the seeds so selected germinated. Every precaution was taken to insure the same conditions for each of the plates. The temperature of the greenhouse was kept as nearly uniform as possible and read at regular hours both day and night. The time the seeds were planted was noted carefully. One hundred seeds were planted in each case and to facilitate counting they were laid in regular order, pressed into the soil even with the surface and covered with filter

paper. The glass covers were not removed for the first twenty-four hours after planting.

The counting of the germinated seeds began forty-eight hours after planting. They were recorded germinated as soon as the radical had pushed through the seed-coat and were again counted when the plumules appeared.

As a check upon the extracted soil free from alkali 100 seeds of each kind were germinated between blotters and filter papers, the edges of which dipped into distilled water to keep them moist. These are reported in columns one and two of the tables. To check the germination in extracted soil 100 seeds were germinated in the natural alkali soil containing 2.24 per cent alkali and in extracted soil to which was added as nearly as possible the same amount of salts. In addition to the per cents given in the tables we tried the same tests in seven, ten, and fifteen per cents alkali, but as practically nothing germinated in five per cent and nothing in stronger alkali than this they are not reported.

EXPLANATION OF TABLES.

In tables I to VI the time in days in the first column is the time from planting the seed, the number germinated being counted at the end of each day of twenty-four hours. Ext. soil, means the natural soil taken from the farm which contained 2.24 per cent of salts, but from which all this alkali has been extracted, and in cases where it contains alkali the salts were made up artificially in the same proportion of different salts as occurred in the soil samples taken and added to the soil in the plates in sufficient amount to supply the per cents given. Nat. soil, means the soil as it was taken from the farm, not treated in any

TABLE I.—TURNIPS.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	3		8									
3	16		35									
4	17	15	50	50								
5	64	38	52									
6	68		54									
7	71		55									
8	80		57									
9	82		58									
10	84		59									
11	84		61		2							
12	84		64		2							
13	85		67		3							
14	85		68		3							
15	85		71		4							
16			75		8	8						
17			77		10							
18			81		13							
19			84		20							
21			92		24							
23			93		37						1	
25			93		43						1	
27					45						1	

way. The figures in the columns headed germ. and plum. respectively are the per cents of the seeds which have germinated in the given time and the per cents of seeds which had the plumule or first seed leaf developed so as to appear through the seed coat.

RESULTS OF THE EXPERIMENT.

The merest glance at any of the tables shows that even small per cents of alkali in the soil will retard the germination of the seed, and the larger the amount of alkali in the soil the greater will be the time the seeds will take to germinate, up to the amount necessary to entirely prevent development of the germ. Were this the

TABLE II.—BARLEY.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	13		15									
3	68		63	17								
4	89	13	88	44								
5	95	78	92									
6	98		95									
7	98				15		1					
8	98				27		3					
9					81		3		3			
10					86	5	3		3			
11					91	7	18		15			
12					94		19		15			
13					96	16	20		19			
14					97	32	21		21			
15					97		25		26			
16					97		32		28			
17							33		31			
18												
19												
21							34					
23							37	4				
25							42		33			
27							45		34	5		

only effect it would be sufficient to prevent successfully raising crops so affected, on alkali soils. Should seeds remain in the soil two weeks before germinating the soil would often become so dry as to prevent further development and the crop would be lost, or in our short seasons, development would be so retarded as to prevent the crop maturing should the plants grow well after starting. Heretofore it has been supposed that alkali destroyed or injured young plants by corroding them at the surface of the ground. These experiments demonstrate that there is a physiological effect upon the vitality of the seed and plant.

TABLE III.—RYE.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	77	45	70	55	27		10		1			
3	89	77	84	67	53	28	29		1			
4	91	72	87	84	63		35		4			
5	95	85	91		70	48	61	36	17	2		
6	96	93	91		75	51	63	37	20	3		
7	96		91		85	60	62?		34	3		
8	96		91		85	69	67	41	34	9		
9	96		91		87	75	75	41	51	15		
10	96		92		89	77	71?		51	16		
11	96		92		91	90	79	63	67	35		
12	96		92		91		75?		71			
13	97		92		91		82		72			
14	97		93		91		84	54?	72			
15	98		93		91		84		73			
16			95		91		87		78			
17					91		88		79		1	
18					91		90				1	
19					91		91		80	40	1	
21					91		91		82		1	
23					91		91		87		1	
25					94		91		87		1	
27					94		92		89		5	

The tables also indicate which of these crops are least susceptible to the influence of alkali. It has long been known that some plants naturally inhabit saline soils as for example, beets, asparagus, "salt sages" or "saltbush" (species of *Atriplex*), some grasses, etc. The tables also show that some of the cereals are much more immune than others. Rye will grow upon soil containing comparatively large amounts of alkali. Wheat comes next in order, then barley and lastly oats which would produce a very poor crop upon soils containing as much as one per cent of alkali in the first two inches of surface. This is shown both in the germinating test and in the field where

TABLE IV.—OATS.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2			1									
3			3									
4			22									
5			37	37?								
6	1		62									
7	1		68									
8	42		75		1							
9	65		83		1							
10	72	17	87		1							
11	82	79	89		1							
12	91		89		1							
13	93	81	89		1							
14	94	82	89		13							
15	94		89		14	1						
16	94		89		15	1						
17			89		15	1						
18					15	1						
19					15	4						
21					24							
23					25				1			
25					26				5			
27					34		14*		7?			

*Leak in roof allowed rainwater to fall in plate.

small amounts of alkali (less than one per cent in the upper two inches of soil) have prevented profitable crops. Turnips are quite susceptible, while alfalfa will germinate in ordinary alkali soil.

Alfalfa is a valuable hay crop and when once started shades the ground preventing the rapid rise of alkali.

The reason that alkali in the soil retards or prevents the development of the germ is not so easily determined. A study of the seeds planted in soil with five to fifteen per cent alkali indicated that the water did not readily enter the seed. They swelled slowly. The outer seed coat on the wheat and rye seemed to swell faster than the starch

TABLE V.—WHEAT.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	18		4		1							
3	36		7	3	2							
4	47	14	25	5	3							
5	60	28	41	16	13							
6	74	49	47		15							
7	82	59	57		17							
8	84	71	73		23							
9	85	75	80		32	10	1		1			
10	85	77	83		34	13	3		1			
11	87	79	87		55	20	4		3			
12	87		89		55		4		3			
13	87		91		55	22	6		3			
14	88		91		55	22	6		3			
15	88		94		56		6		3			
16	92		94		66		7	5	3			
17			94		66	32	14	6	6			
18			94		66		14	6	6			
19			94		67	44	14	6	6			
21			95		67		17		6			
23					68	52	24		8			
25					68		33	15	12			
27					68		33	21	12	3		

inside, leaving it loose and wrinkled. No apparent change could be detected in the germ even when examined under high powers of the microscope. In the alfalfa the seed leaves swelled, cracking open the seed coats, but there was no development of the embryo.

Wheat grains soaked in distilled water and in two and one-fourth per cent solution of alkali imbibed the following amounts of moisture:

Wheat soaked 24 hrs. in distilled water took up 44.182 per cent moisture.

Wheat soaked 24 hrs. in 2.25 per cent alkali solution, 39.942 per cent moisture.

Wheat soaked 96 hrs. in distilled water took up 69.230 per cent moisture.

Wheat soaked 96 hrs. in 2.25 per cent alkali solution, 54.293 per cent moisture.

The alkali seems to produce a physiological effect

TABLE VI.—ALFALFA.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	25		25									
3	35		57									
4	35	22	80	77								
5	82	72	93		1							
6	92		98		1							
7	96	95	100		1		1					
8	99				4		1		1			
9	99				10		1		1			
10	100				23		1		1			
11					73		1		3			
12					78		1		3			
13					79		1		3			
14					80		1		3			
15					80		1		3			
16					86		1					
17					95		2				1	
18					96		2				1	
19					98		2		4		1	
21					99		2		4		2	
23							3		4		2	
25							3		7		2	
27							5		9		2	

which is not necessarily fatal to the life of the germ. In table IV it will be noticed that none of the oats germinated in 2.24 per cent alkali until the twenty-seventh day after planting. During the twenty-sixth day a heavy rain occurred and a leak in the roof of the greenhouse allowed rain to fall into the oat plates containing this amount of alkali. At the end of the twenty-sixth day none were germinated, but at the end of the twenty-seventh day, the alkali having been diluted by the rain-water, 14 per cent were germinated in the natural alkali soil and 7 in the extracted soil containing 2.25 per cent salts. The seeds appear to lie dormant, retaining their

germinating power. Further experiments and investigation will be necessary to determine fully the effects of alkali salts upon seeds of different kinds and no attempt is made to discuss apparent facts which need further study.

THE POT EXPERIMENTS.

In connection with the germinating test and at the same time, a series of pot experiments was carried on. They were planted with the same kinds of seeds as the plates and kept under as nearly the same conditions as could be obtained. Five-inch pots were used, each containing one kilogram (2.2 pounds) of soil. The soil was air-dried and 25 per cent of moisture added at the time the seeds were planted. Five seeds were planted in each pot. The soil was moistened from time to time with distilled water, each pot being given the same amount, and the temperature of the water brought to nearly the same temperature as that of the air in the house. To determine whether the soil is colder when it contains large amounts of alkali a careful series of the soil temperatures in the pots were taken but no difference in the warmth could be detected between the soil free from alkali and that containing 5 per cent of the salts. However, in this connection it should be stated that in the experiment the moisture was controlled so that each soil contained the same amount. In the field a soil containing alkali will retain more moisture than one free from salts, which might make the alkali soil have a lower mean temperature for the growing season.

The pots were set in saucers so the alkali which incrusts on the outside of the pots, as it did on those containing three and five per cents of salts, could be washed

into the saucers from which it was again taken up into the soil with the water. Frequent waterings on the surface kept the alkali from accumulating on top of the soil. In addition to the pots which were filled with extracted soil and natural alkali soil containing 2.24 per cent, 3 per cent and 5 per cent alkali a series was filled with garden soil from the farm which contained only one-tenth of one per cent.

The following notes and illustrations give the results of the experiment:

TURNIPS—PLATE I.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 1.—5 per cent alkali. None came up.

Pot No. 7.—3 per cent alkali. None came up.

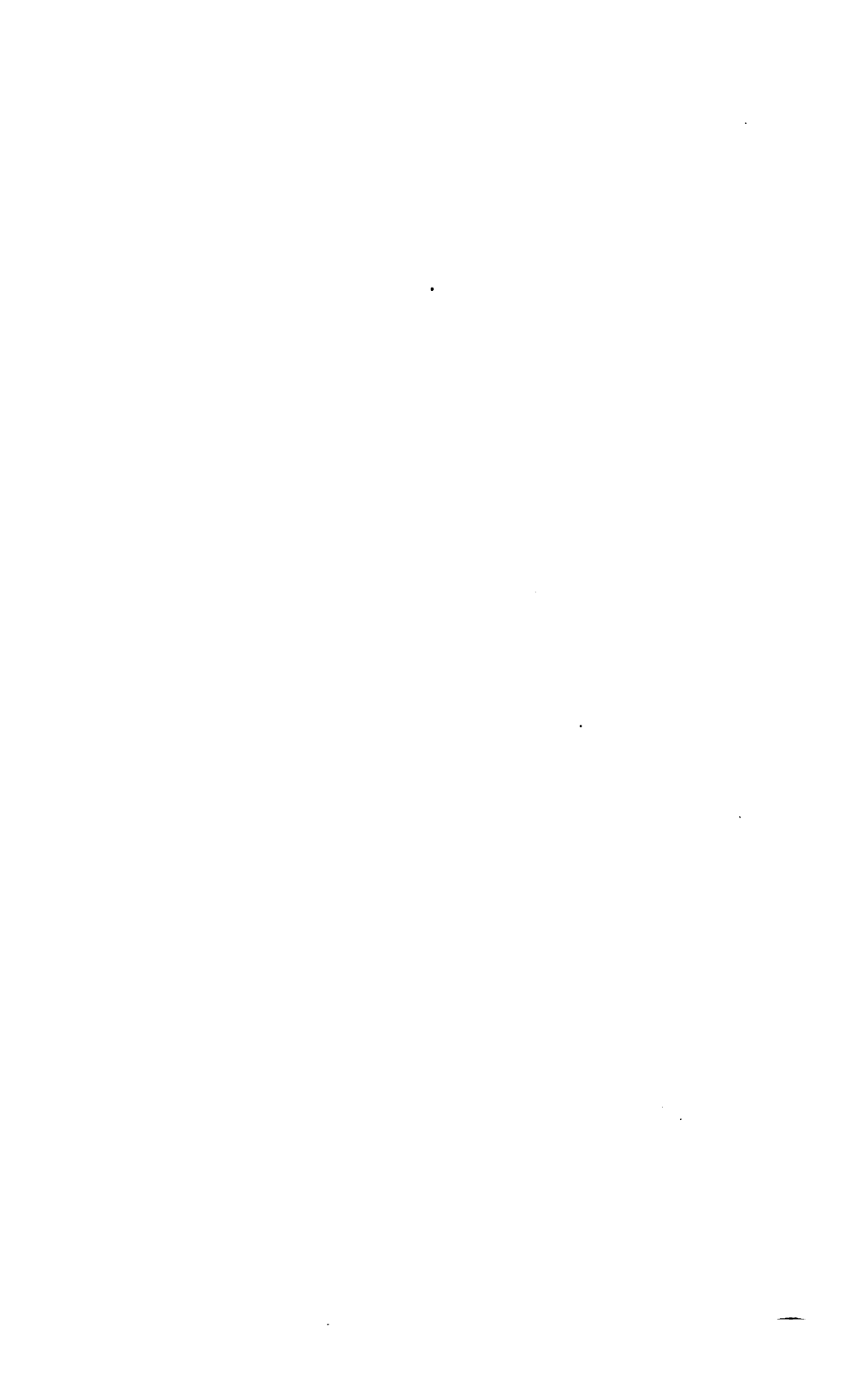
Pot No. 13.—2.24 per cent alkali. In six days three up, in seven days four up, in nine days five were up with seed leaves expanded. In eleven days third leaf started, in seventeen days third leaf well developed. At the end of sixty-five days four plants growing. Longest leaves $4\frac{1}{4}$ inches.

Pot No. 19.—0.104 per cent alkali. In four days two up, in five days four up, in eleven days third leaf well started. In sixteen days third set of leaves started. At the end of sixty-five days four plants with longest leaves from 5 inches to $6\frac{1}{2}$ inches in length.

Pot No. 25.—No alkali. In fourteen days one up. Only one came up. At end of sixty-five days one plant with longest leaves $4\frac{3}{4}$ inches in length.









BARLEY—PLATE II.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 2.—5 per cent alkali. None came up.

Pot No. 8.—3 per cent alkali. In ten days one plant was up, in eleven days two up, in fourteen days three up $\frac{1}{4}$ of an inch to $1\frac{1}{2}$ inches high. In twenty-three days from $2\frac{1}{2}$ to 3 inches high. At end of sixty-five days five plants were up, one $\frac{5}{8}$ inch high, highest plant $6\frac{3}{4}$ inches high.

Pot No. 14.—2.24 per cent alkali. In seven days two up, in eight days four up from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches high. In nine days five were up from $\frac{1}{4}$ inch to $2\frac{1}{4}$ inches high. In sixteen days from $4\frac{1}{2}$ inches to $5\frac{1}{2}$ inches high. At end of sixty-five days five plants were from 11 to 13 inches high.

Pot No. 20.—0.104 per cent alkali. In six days five seeds were up from 1-16 to $\frac{1}{4}$ inch high. In sixteen days from 4 inches to $6\frac{3}{4}$ inches high. At end of sixty-five days five thrifty plants were from 12 inches to 19 inches high. Grain shooting.

Pot No. 26.—No alkali. In six days two up, in eight days three up $1\frac{1}{2}$ inches high, in twelve days four up from $\frac{3}{8}$ inch to 5 inches high, in sixteen days from $3\frac{1}{2}$ inches to $6\frac{3}{4}$ inches high. At end of sixty-five days four plants 18 inches high, shooting.

RYE—PLATE III.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 3.—5 per cent alkali. None came up.

Pot No. 9.—3 per cent alkali. In eight days one plant was up. Only one seed germinated. In sixteen days $4\frac{1}{4}$ inches high. At end of sixty-five days one plant had grown to a height of $5\frac{1}{4}$ inches and died.

Pot No. 15.—2.24 per cent alkali. In four days two plants up, in five days three up, in six days all five were up. In sixteen days from five inches to $7\frac{1}{4}$ inches high. At end of sixty-five days five plants from 13 to 17 inches high. Grain in the boot.

Pot No. 21.—0.104 per cent alkali. In four days four were up, in seven days all five were up. One plant injured while small. In sixteen days plants were from $4\frac{3}{4}$ inches to $8\frac{1}{2}$ inches high. At end of sixty-five days five thrifty plants were from 21 inches to 30 inches high. Grain heading.

Pot No. 27.—No alkali. In four days four seeds up, in seven days five up. In sixteen days from seven to nine inches high. At the end of sixty-five days five thrifty plants were from 22 inches to 30 inches high. Grain heading.





OATS—PLATE IV.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 4.—5 per cent alkali. None came up.

Pot No. 10.—3 per cent alkali. At the end of twelve days one plant was up $\frac{3}{8}$ inch high, in twenty-three days two plants were up $4\frac{1}{4}$ inches and 8 inches high. At the end of sixty-five days the plants had not increased in height.

Pot No. 16.—2.24 per cent alkali. In eight days one up, in nine days two up. In ten days three up, in twelve days four up. In sixteen days four plants 3 inches to 4 inches high. At the end of sixty-five days four plants $11\frac{1}{2}$ inches to 17 inches high.

Pot No. 22.—0.104 per cent alkali. In six days four up, in seven days all five up $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches high. In sixteen days from $4\frac{1}{2}$ inches to $5\frac{7}{8}$ inches high. At the end of sixty-five days five thrifty plants from $17\frac{1}{2}$ inches to 19 inches high.

Pot No. 28.—No alkali. In seven days three up, in eight days four up, in nine days all five were up. In sixteen days $5\frac{1}{2}$ inches to 7 inches high. At end of sixty-five days five thrifty plants 23 inches high, shooting.

WHEAT—PLATE V.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 6.—5 per cent alkali. None came up.

Pot No. 12.—3 per cent alkali. In seventeen days two plants up, $\frac{1}{8}$ and $\frac{1}{4}$ inch high. At end of sixty-five days two plants $\frac{1}{2}$ inch high, both dead.

Pot No. 18 —2.24 per cent alkali. In six days one up, in seven days two up, in eight days three up, in nine days four up, from $\frac{1}{4}$ to $2\frac{3}{8}$ inches high. In thirteen days all five seeds up. In sixteen days 1 inch to $6\frac{1}{2}$ inches high. At end of sixty-five days two plants alive, $5\frac{1}{4}$ and $10\frac{1}{4}$ inches high.

Pot No. 24.—0.104 per cent alkali. In five days two up, in eight days three up, in nine days four up. In sixteen days $3\frac{1}{2}$ to 10 inches high. At end of sixty-five days two thrifty and one weak plant $7\frac{1}{2}$ to 27 inches high, shooting.

Pot No. 30.—No alkali. In five days one up, in six days four up. In sixteen days 9 inches to $9\frac{1}{4}$ inches high. At end of sixty-five days four thrifty plants 24 inches high, shooting.





ALFALFA—PLATE VI.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 5.—5 per cent alkali. None came up.

Pot No. 11.—3 per cent alkali. None came up

Pot No. 17.—2.24 per cent alkali. In four days one up, in five days two up, in six days four up, in seven days all five up. In sixteen days the fourth leaf was showing on all plants. At end of sixty-five days four plants alive, three being fairly thrifty, from $\frac{1}{2}$ inch to 3 inches high.

Pot No. 23.—0.104 per cent alkali. In three days two up, in four days all five were up. In sixteen days the fourth leaf was developed on four of the plants. At the end of sixty-five days four thrifty plants $5\frac{3}{4}$ inches high.

Pot No. 29.—No alkali. In three days three up, in five days all five seeds were up. In sixteen days fourth leaf starting on three plants, one plant had been broken. At the end of 65 days three fairly thrifty plants from 3 inches to 5 inches high.

OTHER WORK.

The second line of investigation given in our classification, viz: The effect of irrigation upon the alkali in the soil has been reported upon by the Chemist in bulletin 24 on Water Analyses. Other work along this line is in progress.

RECLAMATION OF ALKALI SOILS.

(a) *Leaching*.—Where the drainage is good the alkali can be removed by flooding with sufficient amounts of water to carry the salts away with the underground flow. This will also undoubtedly remove some of the soluble plant foods, notably potash, but “of two evils choose the lesser.” If the noxious salts are eliminated the soil will again become productive. Artificial drainage is probably too expensive to put into general practice in this state at present, but in many cases the natural drainage will be sufficient.

DRAINS UPON THE SHERIDAN FARM.

During the summer of 1895 a series of open ditches was dug around and through an alkali plat upon the Sheridan Farm. They are so constructed that the water in times of heavy rainfall or irrigation will be drained from two feet below the surface. The soil is heavy adobe, or gumbo, underlaid with hardpan. Under these conditions it will take a longer time to reclaim than would a loose soil. Reports this year indicate a marked improvement in the alkali plats the first season after draining. Mr. Lewis, the Farm Superintendent, reports that he believes the land will be entirely reclaimed.

Reclaiming by leaching out the surface would be only temporary relief if the alkali salts occur to great

depths in the soil. Recent investigations by Prof. Hilgard show that alkali in California is practically all within the first four feet of surface soil. This discovery is one of the most important which has been made in regard to alkali and like investigations are now under way by our chemist to determine whether like conditions exist in Wyoming. Undoubtedly many of our alkali deposits extend to considerable depths. Where all the salts are within a short distance of the surface, once removing them will permanently reclaim the land.

(b) *Growing Useful Plants.*—Much of our alkali land which will not produce cereals or ordinary farm crops which are susceptible of injury by small amounts of such salts may be made remunerative by growing crops which will thrive under such conditions. Sugar beets will produce good crops upon soil too strong for the cereals or other root crops. Upon the Sheridan Farm White Bokhara clover (*Melilotus alba*) thrived upon strong alkali soil. This clover is not ordinarily relished by stock. Heretofore I have not recommended it for planting as it spreads rapidly, becoming a weed and has been considered of little or no value except as a bee plant. However, in some parts of the west it is cut young for hay, salted and baled, when it is said to be eaten well by all kinds of stock. Alfalfa will grow upon soils which contain comparatively large per cents of alkali, unless the soil becomes too wet. If those locating upon new farms in alkali districts will plant the lower portions of the farm to alfalfa, by shading the ground and preventing the rapid rise of the alkali, it will prevent these parts of the farm being taken by alkali for a much longer time than would otherwise be the case.

There are several species of "Salt Sage" (*Atriplex*) native in the state which are relished by stock, and in fact form the principal feed upon many of the ranges. They naturally thrive upon alkali soils and may prove of value to plant upon alkali land on the farm. A plant belonging to the same genus known as "Australian Salt Bush" has proven successful on alkali lands in California and its value for this state is being investigated upon the Experiment Farms.

PREVENTING THE RISE OF ALKALI.

The old saying that an ounce of prevention is worth a pound of cure can be well applied to our conditions of alkali soil. Land which might become unproductive in two or three years, with proper precautions may be made to produce crops for a much longer time. The most important point to observe is the prevention of evaporation by keeping the soil shaded. This may be done by keeping it in some crop, such as alfalfa as recommended above or by mulching. Such mulch may be litter hauled onto the soil or formed through cultivation of the surface, leaving three to eight inches of well pulverized soil on top which will act as a mulch.

After each irrigation, unless the soil is well shaded by crop, it should be cultivated as soon as it can be worked in order to break up the capillary action which furnishes water to the surface for evaporation.

SUMMARY.

The white alkali of general occurrence in Wyoming consists principally of sulfates of sodium and magnesium.

One per cent or more of these salts in the first two inches of surface soil will make it unproductive for any but plants which naturally inhabit saline soils.

Small amounts of alkali in the soil retard germination and growth in proportion to the amount present. This effect is physiological. •

Alkali soil may be reclaimed by leaching out the salts, where there is drainage naturally or artificially supplied.

The rapid rise of alkali may be checked or prevented by hindering surface evaporation through cropping and proper cultivation.

Plants that thrive comparatively well on alkali soil are sugar beets, White Sweet Clover (*Melilotus alba*), "Salt Sages" (species of *Atriplex*), and alfalfa under certain conditions. Rye does better than other cereals.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 30.

SEPTEMBER, 1896.

STOCK FEEDING EXPERIMENTS AT LANDER.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING

Agricultural Experiment Station.

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STOCK FEEDING EXPERIMENTS.

B. C. BUFFUM.

The experiments here reported were carried on upon the Lander Experiment Farm during the winter of 1895-'96, under the direct charge of the superintendent, Mr. J. S. Meyer, and his assistant, Mr. H. S. Kendall. The results here presented are computed from the notes furnished by them.

The following is a letter from Mr. Meyer in regard to the general objects of the feeding tests:

“ What seems to me to be the object of feeding stock in Wyoming, is to ascertain the cost of having fat stock for the spring months when we cannot depend on the range to furnish us with a good quality of meat. There has been a time when good meat could be killed off the range in any month of the year, but that day has passed. We must now begin to feed our stock for at least the latter part of the winter and the early spring months, to supply our home market. Where shipping facilities are convenient, there should be no reason why Wyoming cannot feed stock profitably for the eastern markets, if by experiments we find we can produce good meats with our grain, hay, and root crops so as to be able to compete with our neighbor corn-growing states. And, while too few of our farmers are figuring on making a profit out of feeding their crops to stock, the time is now

at hand when they should figure on feeding their crops and marketing them in stock, instead of selling to government posts, freighters, etc., as this market is too uncertain and too limited to depend on. If, however, we depended on feeding our crops, it would not be any longer a question of how much we are going to find a market for. The question would be then, how much can we raise of such crops as can be profitably fed or consumed by stock.

"Carrying on feeding experiments in our state with our various crops, so as to ascertain the best and cheapest way of fattening our stock, will certainly be of great value to the citizens of Wyoming as well as to other states raising the same crops as we do, or who are similarly situated.

"If the Experiment Station carries on these feeding experiments it will be only a short time until the best methods of feeding will be understood and our citizens can begin at once marketing their crops in stock. If the farmers have to make these experiments alone, it will take years to accomplish the same end."

It should be stated that the direct object of this test, is not to add to the scientific principles upon which stock feeding is based, but merely to show what can be done in feeding with the materials at hand. The results are published for the benefit of our farmers and ranchmen who are seeking such information.

It will readily be seen that the rations are not well balanced. However, with the materials at hand it would be difficult to feed correct rations. For example, in the sheep feeding test, during the last period, when the combination of foods gives the nearest balanced ration, the nutritive ratio is 1: 5.8, which is too wide. In order

to narrow it down to the standard it would be necessary to add oil cake or some other concentrated food, which would have been hardly justifiable in this case. No doubt the rations could be improved and we hope to show in future experiments the advantage of balancing them so far as may be and use our own products. Farmers that feed are recommended to follow as nearly as possible the general rules on stock feeding given in Bulletin 13 of this Station.

FEEDING STEERS.

Six steers were purchased. They were from the open range, but had been put in the fields and winter fed. On this account they were in fair condition for beef with the exception of steer No. 6, which was only in fairly good order; in consequence of this he made a greater gain than any of the others. All were coming three years old and had been dehorned a year or more.

Nos. 1 and 2 were grade shorthorn. No. 1 was wild and did not become tame during the whole experiment. No. 2 was a good feeder, though a little nervous. Nos. 3 and 4 were grade polled Angus, took kindly to feeding, were always lively, and had good appetites. Nos. 5 and 6 were ordinary range steers. No. 5 was a fair feeder, but a little nervous. They were fed second cutting alfalfa hay and had access to running water at all times except for three hours before weighing. On April 1st No. 5 became sick and took no grain till the 9th. From that time till the 20th he was fed the same ration as during the intermediate period.

The first feeding period began on January 19th. All were fed alfalfa hay up to March 1st, a total of

41 days. During this time they were given 6,549 pounds of hay, of which they consumed 5,529 pounds, or an average consumption of 22.48 pounds per day for each steer.

At this point in the experiment the steers were divided into two lots of three each. Lot No. 1, consisting of steers Nos. 1, 3, and 6, were fed on alfalfa hay and sugar beets. Lot No. 2, consisting of Nos. 2, 4, and 5, were fed on alfalfa hay, chopped oats, and cracked wheat. Beginning on March 1st and continuing for 11 days the two lots were fed respectively on an increasing daily ration of sugar beets and grain until they reached the amount to to be fed during the last period, which was 14 pounds of sugar beets apiece to those in lot No. 1, and 7 pounds of chopped oats and 9 pounds of cracked wheat apiece to those in lot No. 2. The average amount of beets fed daily to each steer for this period was 9 pounds. The average amount of grain was 4 pounds of oats and 5 pounds of wheat. During this intermediate period the steers were fed 4,914 pounds of hay, of which they consumed 4,061 pounds, or an average daily consumption for each of 23.34 pounds.

On March 12th the last period was begun, which lasted 40 days, ending April 20th. During this time the steers were fed 7821.5 pounds of hay, of which they consumed 6,505.5 pounds, or an average daily consumption for each of 26.03 pounds, the amounts of hay eaten by the two lots not being kept separate. As stated above, lot No. 1 was fed 14 pounds of sugar beets with the hay, lot No. 2 being fed 7 pounds of chopped oats and 9 pounds of cracked wheat with the hay.

The following shows the gain for each steer during the different periods. The minus sign signifies a loss.

Gain.				
	Initial weight.	Gain for first period, 41 days.	Gain for intermediate period, 11 days.	Gain for last period, 40 days.
	lbs.	lbs.	lbs.	lbs.
Steer No. 1—grade shorthorn	1024	34	2	7
Steer No. 2—grade shorthorn	962	78	6	43
Steer No. 3—grade polled Angus	932	128	-34	67
Steer No. 4—grade polled Angus	902	103	-5	41.5
Steer No. 5—range	876	91.5	6.5	-9*
Steer No. 6—range	996	109	-15	53
				147

COST AND PROFIT--STEERS.

The two grade shorthorn steers cost \$30 each, the two polled Angus \$25 each, and the two range \$25 each.† The steers were sold at the close of the feeding period for \$3.35 per hundred pounds live weight.

Prices allowed for feed are, alfalfa hay \$4 per ton, sugar beets \$3.50 per ton, and wheat and oats \$1 per hundred pounds. No account is taken of the cost of preparing the food of, feeding and caring for the cattle, the interest on the money invested in the stock, or the hay which was wasted.

The following are the results from a financial standpoint, based on the above quotations. The six steers are taken together.

Average selling price of each	\$35.72
Average cost price of each	\$26.66
Average gross profit on each	\$ 9.06
Average cost of feed for each	\$ 8.47
Average net profit on each	\$.59

To estimate the exact cost of the gain obtained from the sugar beet or grain rations, it can readily be seen that

*This steer was sick during April.

†"The price paid for 'feeders' this year was higher than usual, and caused many farmers to feed at a loss."—J. S. MEYER.

it is necessary to find the average cost per pound of the six steers so that the actual cost price, according to weight, of each lot of steers may be determined. The average price per pound paid for the six steers was 2.81 cents.

The two lots, one being fed during the last period on alfalfa and sugar beets, the other on alfalfa and grain, are here compared.

	Average initial weight.	Average price according to weight.	Average final weight.	Average selling price.	Average gross profit.	Average cost of feed.	Average net profit.	Average net loss.
Lot fed on hay and sugar beets	884	\$27.65	1101.3	\$36.88	\$9.23	\$ 5.78	\$3.45	
Lot fed on hay and grain, . . .	913.3	\$25.66	1031.8	\$34.56	\$8.90	\$11.28		\$2.38

A comparison of the results obtained from the grade shorthorn, grade polled Angus, and range steers is here given. As has been noted there were two of each kind, one of which was fed on alfalfa and sugar beets, the other on alfalfa and grain, during the last period.

	Cost price.	Selling price.	Gross Profit.	Cost of Feed.	Average net profit on each.	Average net loss on each.
Shorthorn, ...	\$60	\$72.23	\$12.23	\$17.80		\$2.78
Polled Angus, ...	\$50	\$71.51	\$21.51	\$17.80	\$1.85	
Range, ...	\$50	\$70.61	\$20.62	\$16.52	\$2.55	

From the above table it would appear at first thought that grade shorthorns were poor cattle to feed. This is doubtless misleading, for in this particular case a much higher price per pound was paid for the shorthorns than for the other kinds.

SUMMARY FOR STEERS.

Average gain per head for six steers while on feed, 92 days, 117.5 pounds or 1.28 pounds per day.

Average gain of three steers fed alfalfa and sugar beets, 117 pounds or 1.27 pounds per day.

Average gain of three steers fed alfalfa and grain 118.2 pounds or 1.284 pounds per day.

The grade shorthorns gained 85 pounds each.

The grade polled Angus gained 149.7 pounds each.

The range steers gained 118 pounds each.

Lot No. 1 made an average gain in first period on hay of 2.2 pounds per day. In last period on hay and beets they made an average gain of 1.06 pounds per day.

Lot No. 2 in first period on hay made an average gain of 2.36 pounds per day. In last period on hay and grain, they made an average gain of 1.14 pounds per day.

The lot fed on alfalfa and sugar beets returned a net profit, above a fair price for feed given, of \$3.45 apiece, and the lot fed on alfalfa and grain a loss of \$2.38 apiece.

Net profit on the six steers was \$.59 each. This would be sufficient to pay for feeding where large numbers were handled.

SHEEP FEEDING.

The sheep used for this experiment were purchased from the only range bunch accessible at the time. Three ewes four or five years old and three spring lambs of 1895 were purchased. The price paid for the sheep upon the range was \$2.50 apiece for the ewes, and \$2 apiece for the lambs. The six sheep actually cost the station an average of \$3 apiece, but the extra amount was paid for delivering them and is not taken into account in the results given below; as sheep when purchased in large numbers for feeding would not be subject to great expense for delivery.

All the sheep were mutton fat at the beginning of the experiment on December 1st, and consequently were not as good for the test as could be desired.

Throughout the experiment they were fed at 8 a. m. and 6 p. m. each day; and were weighed at 10 a. m. every

third day during the first and second periods, and once a week during the last period. They had a small corral in which to exercise and had access to fresh water at all times. They did not become quiet under handling, but fretted almost as much at the last weighing as at the first. The hay fed was second cutting alfalfa, and the grain and roots were grown on the Station farm. The value of the hay is placed at \$4 per ton in the stack, the sugar beets at \$3.50 per ton, which is sufficient to more than pay the cost of raising them, and the grain at \$1 per hundred pounds.

The food was weighed to the sheep night and morning and the orts or waste weighed back in the morning.

The experiment was carried through three feeding periods. During the first period, from December 1st to February 1st, the ewes were separated from the lambs and both lots were fed hay. At the end of the first period they were divided into three lots of two each, each lot being composed of one lamb and one ewe. During the second period, from February 2nd to March 2nd, lot No. 1 was fed hay alone, lot No 2 hay and sugar beets, and lot No. 3 hay and cracked wheat. During the third and last period all were put together and fed hay, sugar beets, and cracked wheat to "top them off" for market.

Gains.

	Weight on December 1st.	First period, 63 days.	Second period, 30 days.	Third period, 24 days.	Total gain.
	lbs.	lbs.	lbs.	lbs.	lbs.
Ewe No 1.	94	5	1.5	6.5	13
Ewe No. 2.	105	4	7.25	7	19
Ewe No. 3.	109	5.5	1.5	3.25	10
Lamb No. 1.	66	1.25	3.75	10	15
Lamb No. 2.	60	4	8.5	1.5	20
Lamb No. 3.	64	7	3.75	8.25	19

Food Consumed.

Lot Number.	First period.	Second period.			Third period.			Total	Total	Total
	Hay.	Hay.	Beets.	Grain.	Hay.	Beets.	Gr'n.	Hay.	Beets.	grain.
No. 1, ewe and lamb	302	177			120	140	56	509	140	56
No. 2, ewe and lamb {	302	122	{ 06 52 }		120	140	56	544	258	56
No. 3, ewe and lamb {	302	102		{ 18.25 18.25 }	120	140	56	524	140	92.5

The total food consumed in 2409.5 pounds, and the total gain 93 pounds, giving one pound of gain for each 25. 9 pounds of food eaten.

COST AND PROFIT.

At the close of the feeding test the sheep and lambs were sold for six cents a pound net. The weights, dressed, were, ewes, No. 1, 54 pounds; No. 2, 60 pounds; No. 3, 57 pounds; lambs, No. 1, 38 pounds; No. 2, 35 pounds, and No. 3, 38.5 pounds. The mutton produced in per cent of the live weight was 49.3 per cent for the ewes, and 45.7 per cent for the lambs, or an average of 47.8 per cent.* The pelts of the ewes brought 80 cents each and of the lambs, 60 cents each.

With the values of alfalfa, beets and grain given above we have the following table of results:

	Cost of sheep.	Value of feed.	Total Cost.	Value of meat.	Value of pelts.	Total value.	Net profit.	Kind of feed in second period.
Lot No. 1.	\$4.50	\$2.60	\$6.50	\$5.52	\$1.40	\$6.92	\$.42	Hay.
Lot No. 2.	4.50	2.10	6.60	5.70	1.40	7.10	.50	Beets.
Lot No. 3.	4.50	2.22	6.72	5.73	1.40	7.13	.41	Grain

*This seems to be low, as results in other states show from 5 to 9 per cent more mutton.

The following comparison of cost and profit with the ewes and lambs may be of interest:

Lambs.				Ewes.			
	Cost	Value.	Loss.		Cost	Value.	Profit.
No. 1.	\$2.97	\$2.88	\$.09	No. 1.	\$3.52	\$4.04	\$.52
No. 2.	3.01	2.70	.31	No. 2.	3.59	4.40	.81
No. 3.	3.08	2.91	.17	No. 3.	3.63	4.22	.59

The total value at 6 cents per pound net gives \$3.44 per hundred pounds live weight for the lambs, and \$3.65 per hundred pounds live weight for the ewes.

During the experiment 1,507.5 pounds of hay were weighed back as orts or waste. This would have a value of \$3.01 and where wasted would add to the cost, but in feeding sheep nearly all this waste may be saved by feeding it to cattle or other stock. The larger part of the waste hay left by one kind of stock will be eaten by another. This should always be taken advantage of in feeding mixed stock.

SUMMARY FOR SHEEP.

The lot fed hay and sugar beets during the second period gave better returns than those fed hay alone or those fed hay and grain.

The ewes gave better gains and greater profit than did the lambs.

The average results of the six sheep show a fair return for the feed given, with enough profit to meet all expense of feeding where larger numbers are handled.

The rations fed were not properly balanced and give a ratio which is too wide. The best balanced ration gave the best returns in each case.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 31.

DECEMBER, 1896.

The Worst Weeds of Wyoming

... AND ...

Suggested Weed Legislation.

BY THE BOTANIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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To the Citizens of Wyoming.

The Experiment Station exists in order that it may be of service to the people of this State in particular, and to the agricultural interests of all in a general way. To this end it is due the Station that it have the hearty co-operation of all whom it is intended to serve. Its highest usefulness will be attained so soon as the efforts of the station workers can be concentrated upon the problems which press most urgently for solution. This cannot be accomplished unless the constituency of the station will place themselves as individuals in communication with the workers of the station, from whom they would like help. Let the problems which confront you be freely communicated, and the station will help you solve them, devoting special time to it if it be a problem of general interest.

The botanist invites correspondence on all topics of economic interest concerning plants, such as the prevalence of important weeds, the best means of destroying them, the appearance in any locality of new ones, any unusual development of old ones, the diseases of any of the cultivated crops due to Fungi, or any questions of that character.

He will determine any plants sent for that purpose. Material sent for identification should be as complete as possible. If the plant be small, send the entire plant or several of them. These should, where possible, have leaves, flowers and fruit. Of larger plants send a part containing average leaves with flowers and fruit, if it can be had. Portions of diseased crop plants may also be sent for determination of the Fungus causing the disease. All such material can be sent fresh by mail if closely wrapped in newspapers, or can first be dried under pressure between thick pads of newspaper and then sent by mail between pieces of paper securely protected by heavy pieces of cardboard.

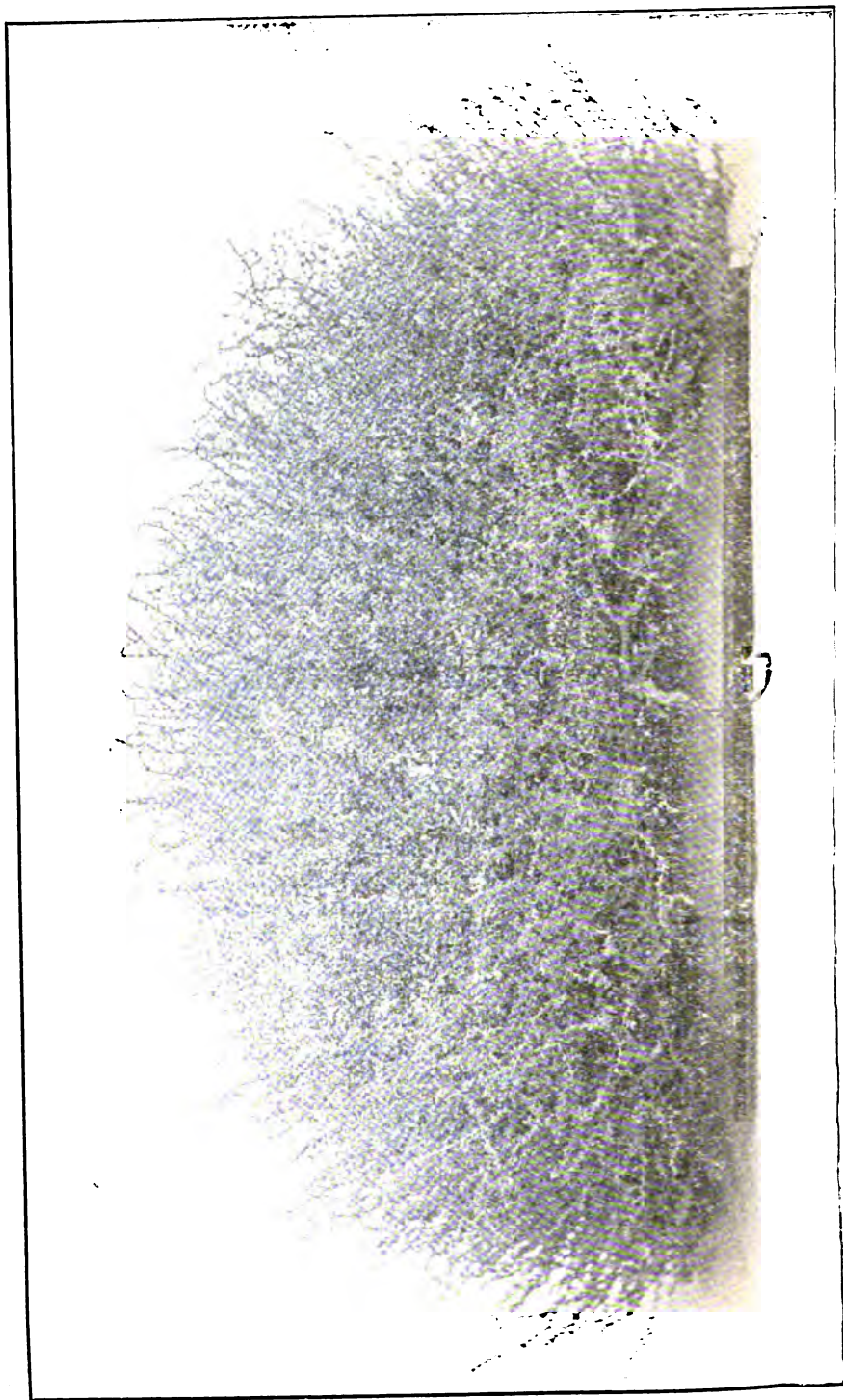
All packages should be marked with sender's name and address, and be accompanied with a letter of explanation.

All communications of a botanical nature should be addressed to

THE BOTANIST,

Experiment Station,

Laramie, Wyoming.



The Worst Weeds of Wyoming.

AVEN NELSON.

THE NATURE OF WEEDS.

As indicated in the title of this bulletin, it is not the intention of the writer to attempt at this time an exhaustive treatment of the subject of weeds. Its very nature is such as to preclude the hope of saying the final word on this subject. That this must be so is readily understood if we will call to mind what weeds are, and that the term *weed* is largely a relative one. The *weediness* of a plant depends in many cases upon the observer's point of view; that is, a plant is pronounced a weed, *bad* in proportion to the hindrance it offers to the production of that which is at that particular time and place the desirable, or *good*.

It has often been said that a *weed* is only a plant out of place, which may be accepted if we will add that it is one that *insists* on growing where it is not wanted.

It may be well to remember that there were no weeds anywhere till man appeared and found that certain plants could serve for him certain economic purposes. At first such plants as were from time to time found of use, were simply sought out from those places where they had succeeded in maintaining themselves in spite of the severe competition to which all plants in a state of nature are subjected. As these plants or their products became more and more desirable it dawned upon first one and

then another to assist these desirable plants in their struggle for existence. This it was found could be done in two ways; by keeping down the other plants with which these were competing, or by removing the desirable ones into new localities where competition would be less severe.

When this point had been reached in man's struggle with nature, agriculture had its inception, and from that day to this some plants have been favored and others repressed by the hand of man.

On each of these two classes of plants this kind of treatment has produced its legitimate result. The undesirable class has grown more aggressive, holding its ground more stubbornly in each succeeding generation, developing but one quality, namely, that of maintaining and propagating itself under the most adverse circumstances. The desirable class, as it was more and more relieved from the necessity of striving for space, for food and for sunshine, developed its useful qualities to a greater degree, but on the other hand it became less and less fitted to struggle single handed, as it were, with its natural enemies.*

This dependence upon man has been and is still constantly being intensified by man's selective agency. For purposes of propagation those plants are selected which have shown a tendency to produce the desirable product in greater abundance or of more perfect quality, hence it has come about that nearly all plants of economic importance are man's wards, dependent upon him for their

*The oft used phrase, "Struggle for existence," given to us by Darwin, is used as he used it, in a large, metaphorical sense. Not even in the animal world is this struggle often an active combat, but it is none the less real and relentless. If one secures in a legitimate way, by reason of superior endowments, what a thousand need in order to maintain existence but only one can have, the struggle is just as actual, though it is an unconscious one, and the results to those that fail just as inglorious.

very existence, but rewarding him for his care by a superabundance of food materials, superior fibres for his various fabrics, and for his æsthetic sense a wealth of beauty surpassing an artist's dream.

These, then, are the two classes of plants with which the tiller of the soil has to deal, one class representing all those that are at present known to be valuable to man; the other those which to a greater or less extent interfere with the most successful production of the first. To these last in a general way the term *weeds* is applied, but in its more restricted sense the term is applied to the larger or seed producing plants which come into direct competition with our cultivated plants by occupying or attempting to occupy our orchards, our gardens and our fields. Also, as previously suggested, the term has a significance relatively considered. The same plant may at different times be both a weed and a valuable plant. A volunteer crop of buckwheat in a cornfield is no less a weed than a thistle in a hayfield, hence plants cannot all be arbitrarily separated into *good* and *bad*, as the classification of some will depend upon the cultivator's point of view. For our present purposes, then, a weed may be defined as any plant which, by taking possession of the soil, reduces the quantity or quality of the desired crop, or becomes in any way an offense to the eye or an obstruction upon the lands in question.

THE EVOLUTION OF WEEDS.

Thousands of kinds of plants are found growing in greater or less abundance upon the earth. These all strive to perpetuate themselves, some in one way, some in another, but most of them produce seeds or spores which are intended to secure the continuity of the plant's life in

that of new individuals successively produced. It can easily be shown that even the forms which produce the smallest number of seeds per plant, produce enough to cover the whole earth in a few years if each seed were allowed to germinate and develop. What, then, must be the condition when the thousands of kinds of plants, some of which literally produce tens of thousands of seeds, are striving to perpetuate themselves! How fierce must be the competition for place and food! As a result of this struggle for existence, some have adapted themselves to one condition and mode of life and some to another. In the life histories of the races which each represents we see intensified all those variations which have favored them in this fierce combat, not only with other forms, but even with those of their own kind. Those forms which have been able to adapt themselves to the most diverse conditions, to develop the most successful expedients for reproducing their kind and to most surely withstand adverse environments, are the plants which are now our *worst weeds*. These characteristics as displayed in the weeds of the following list will be considered in connection with each.

THE NOXIOUSNESS OF WEEDS.

All who have had any experience with weeds know only too well that some weeds are always an unmitigated nuisance and most of them a constant source of annoyance and financial loss. Few, however, realize to what extent the failure or partial failure to obtain remunerative results in their agricultural ventures is due to the weeds that run rampant in their fields and fence corners. The losses are always occasioned in several ways, among which may be mentioned the following: The weeds crowd out

or shade out the less vigorous plants of the crop, thus reducing the number from which returns may be expected; they abstract from the soil such large quantities of plant food that the crop plants that do survive are not able to attain full development, and so yield inferior products that are unsalable or at best bring but small returns; they interfere with the most expeditious and economic methods of harvesting, and the harvested products, because of admixture with weeds or their seeds, sink still lower in market value; they may cause serious injury to stock, as in the case of Squirrel-tail Grass and some thistles; they may cause serious injury to such animal products as wool by reason of their hooked seeds clinging to and becoming involved in it as do all sorts of burs; the farm itself becomes less and less valuable, and the difficulty of disposing of it greater, for the intending purchaser sees the evidences of an impoverished soil well seeded to weeds. The fences to some extent concealed in the weeds on either side do not create a desire in any one to possess the enclosed acres. That sometimes some use can be made of some weeds does not prove that weeds are a good thing; it may be worth while to save a crop of Rag-weeds in times of scarcity, but it were better to grow something else.

THE PERMANENCY OF WEEDS.

Weeds, like the poor, we have always with us, and again like the poor, they are the most numerous in the most shiftless communities. As shiftlessness causes poverty and poverty induces shiftlessness, so shiftlessness endures weeds and weeds cause poverty now just as they did in the time Solomon. It is possible now as then to go by the field of the slothful and see it all overgrown with thorns and thistles, with the usual accompaniment of the

broken down wall,—all evidences of a little more sleep and a little more folding of the hands. Now, as then, poverty comes to such a place as one that travelleth, and want as an armed man ; but do we, as Solomon, look upon it and receive instruction ?

CLASSES OF WEEDS.

With reference to their natural period of life, weeds are spoken of as (1) Annuals, (2) Biennials and (3) Perennials.

The first are reproduced from seed each year, and are easily destroyed, as a rule, by uprooting, and will be eradicated if all the plants springing from a given crop of seed are destroyed. It is well to remember, however, that all the seeds do not germinate the first season. In many cases it is in the nature of the seeds for a part to grow the first and the rest the second year or even later. If the conditions are unfavorable, as lack of moisture or being buried too deeply, they may lie dormant for several years and then spring up, much to the wonder of the farmer as to their origin.

The second live two years, storing up food in the tissues during the first season in order that seed in superabundance may be rapidly produced during the second. These yield to the same methods of extermination as the first.

The third, living for a number of years, are, as a class, the most troublesome. Such perennials as are classed as weeds do not depend upon seeds alone for their propagation. They are provided with underground stems, known according to their structure and form, as rootstocks, bulbs, corms or tubers. These have the power of giving rise to new plants ; and separation from the parent plant,

or even dismemberment of these underground stems, only serves to facilitate the production of new individuals. To this class belong those which most stubbornly resist eradication, as for example the Canada Thistle and Quack or Couch Grass. Many of our worst weeds, however, belong to the other classes, not because the individual plants are hard to kill, but either because of the vast number of seeds produced or the remarkable contrivances for securing their wide dispersal.

For convenience weeds may again be divided into two classes, viz: 1, *Cosmopolitan*, and 2, *Local*. In the first class we will place those which, on account of some remarkable power of propagation or some extraordinary vitality, are at home anywhere and are therefore peculiarly difficult to eradicate. These often require concerted action on the part of communities or states to secure their extirpation and thus avert the loss and annoyance which their complete establishment would entail. In this class we find our worst weeds, but it is to be remembered that such a term can be only a relative one. The worst weeds of one community are not necessarily those of another, for differences in soil, in climate and in character of crops will determine which are most to be feared. In the second class are all other weeds which yield to the ordinary means, viz: cultivation of the ground; in fact, they are rarely found outside of cultivated ground, and if so found are of no particular detriment. This class may very properly be left to individual concern, for the thrifty husbandman will see to it that his crops do not suffer on account of them, and the careless will have to be left to his own folly so long as he does not by his neglect inflict injury upon others.

PURPOSE OF THE BULLETIN.

I do not cherish the Utopian dream that we shall ever be rid of weeds, but there are some kinds that ought to receive the most earnest attention, not only on the part of individuals immediately concerned, but by the State as a whole. It is the purpose of this bulletin to call attention to such, to assist in making them known, to point out the dangers to be feared from each, to help in solving the difficult problems connected with their eradication, and to suggest some needed legislation looking to this end.

In order to secure community of action in this matter it is necessary that the worst pests shall be known and recognized by all. To this end a few of those which, in the judgment of the writer, are at present most to be feared are illustrated and briefly described. As the only object in view is ready recognition of the plant, non-technical language is used, reliance being placed upon the illustrations for enforcing the descriptions. It would be an easy matter to run up a list of a hundred or more weedy plants, but it seems wiser to direct attention to a few very aggressive ones that are weeds first, last, and all the time.

RUSSIAN THISTLE,

(*Salsola Kali Tragus* (L.) Moq.)

As it is intended to consider the weeds of this list in the order of the danger they present to our agricultural interests, the Russian Thistle is placed first, for the danger it threatens is both real and imminent. It has already inflicted untold injury upon the farmers of some of our neighboring States, viz: Nebraska, Iowa, Minnesota and the Dakotas. Several other States are suffering more or

less, but having grappled sooner with the problems of its repression, much has been done in some of them to prevent its securing a foothold. In all of them active measures have been taken, which are doing much to restrict it, even in the worst infected States.

Wyoming cannot afford to delay in this matter; the pest is well established within our borders, and will, in another season or two, be entirely beyond our control. Our climatic and soil conditions are just such as to make this the ideal home of this dangerous tumbleweed.

HISTORY OF THE PLANT.*

The plant seems to be native on the plains of southeastern Russia, where it has long been a troublesome weed. It found its way into the United States in 1873 or '74, having been brought to South Dakota in flaxseed imported from Russia. The land where it was introduced being somewhat broken, and corn the principal crop, it did not at first spread very rapidly. It was not till about 1888 that it had thoroughly established itself in South Dakota, but about this time it spread beyond her borders and invaded North Dakota on one side and Iowa on the other.

From this time on its dispersal has been rapid beyond all precedent. History records no instance of so much territory invaded by any plant in so short a time, for in these few years it has appeared in nearly all the States from California to New York, and from Canada on the north to Kansas and Colorado on the south.

*Mr. L. H. Dewey, Assistant Botanist of the Department of Agriculture, has studied the Russian Thistle in all of its aspects very carefully. The results of his investigations have been published in Farmers' Bulletin No. 10, 1893; and a much fuller report in Bulletin No. 15 of the Division of Botany. These publications are the sources from which much of the information concerning this weed has been drawn for the now rather extensive literature upon the subject. Several of our Experiment Stations have, however, added greatly to our knowledge of it. All of these sources have been freely drawn upon by the writer, who hereby gratefully acknowledges his indebtedness.

Two causes have contributed to this unapproachable record, viz : first, its peculiar facility in distributing its seeds, naturally on its own account, artificially, by man's aid, in hay, in grain, and in seeds generally ; second, suitable soil and favorable climatic conditions. It is just one more instance of the fact that some plants and animals, when transferred to a new locality, find more favorable environments than in their native home. Most of our truly troublesome weeds are of European origin.

ITS HISTORY IN WYOMING.

Though reported from a few points in the State in 1893, it is probable that all such reports were due to persons mistaking other more or less similar plants for the one in question. At least this was so in the cases verified.

Not till the fall of 1894 was an authentic specimen communicated to this Station. This was received from Mr. F. J. Stanton, of Cheyenne, who wrote that it was fairly well established at some points near the railroad. A press bulletin was at once issued sounding a note of warning, which received large publicity through the papers of the State. To this in part may be due the apparent freedom from the weed except along railroad lines, for this placed every suspected weed under the ban.

In 1895 specimens were received from Douglas and Frederics, and this season, 1896, the writer has observed it in a large number of places, in fact at every railroad point visited in a somewhat extended botanical collecting trip.

On the line of the Union Pacific it was plentiful both at Laramie and Cheyenne, at the latter place in all waste ground, sometimes almost to the exclusion of other weeds. On the Cheyenne and Northern, specimens were not rare

at Wheatland, Uva, Badger and Orin Junction. The crop on the Elkhorn at Lusk, and on the Burlington at Newcastle, Moorcroft, Sheridan, Ranchester and Parkman was even more prolific. As these, the only points at which personal investigation was made, were all infected, it seems justifiable to suppose that the weed is found at most points upon all of these lines.

Prof. W. C. Knight, of this Station, reports it abundant at Casper and at various points upon the freight road between that point and Lander, viz : on Poison Spider Creek. At these points it has probably been introduced by seeds in the grain which the freighters have fed at the camping places along the trail.

METHODS OF DISPERSAL.

The Russian Thistle belongs to the class of weeds properly called *Tumbleweeds*. It is not a thistle at all, and has been so called only on account of its spines. It would have been more in keeping to have called it the *Russian Tumbleweed*.

Tumble weeds are plants which usually branch freely, assuming in the course of growth a somewhat spherical form. These plants are annuals, and when mature and dead the one comparatively slender root is easily snapped by the wind and the plant is set adrift, to be threshed over miles of prairie and plain by every storm. On treeless and fenceless areas they travel till worn out, and, as their seeds are not readily dislodged, the thousands* that each plant bears may be distributed over scores of miles. This, while true of all tumble weeds, is especially true of the Russian Thistle.

*A plant of average size, weighing when dry 3 or 4 pounds, it is estimated bears upwards of 30,000 seeds; while the largest, sometimes weighing 20 pounds when dry, bears 150,000 to 200,000 seeds.

But were this the only manner in which its seeds are scattered it would not be so bad, for there are some natural barriers which it would hardly cross. Hay and grain and seeds in general are sent from infected areas, bearing, perhaps, the one seed which serves to infect a new region. Stock cars in their hay and litter carry the seeds from State to State, as evidenced by the fact that almost invariably the points of first appearance are on railroad lines, particularly about stock yards and other places where cars are cleaned from time to time.

SPECIAL DANGER IN WYOMING.

The belief that Wyoming has more to fear from this weed than most of the other States is based upon the following facts : The Russian Thistle belongs to a family of plants, the Chenopodiaceae, of which we have many native representatives. In common with many of these it thrives in all soils, but seems even to be favored by a percentage of alkali. Drought is no hindrance to it ; it matures a crop when all else fails.

Our large areas of unoccupied lands, treelees and unfenced, offer unobstructed and immediate dispersal.

While it is true that it is not able to establish itself in well sodded ground, it is equally true that the open and imperfect sod of many of our native grasses do not resist its encroachments. At several points along the railroads it was observed among Blue Stem and other grasses. Once established on the general range, where it is everybody's or nobody's business to destroy it, it will never be exterminated. Viewed from this standpoint then it cannot be attacked too soon while it is yet, chiefly at least, upon railroad lines and in and about our towns and villages.

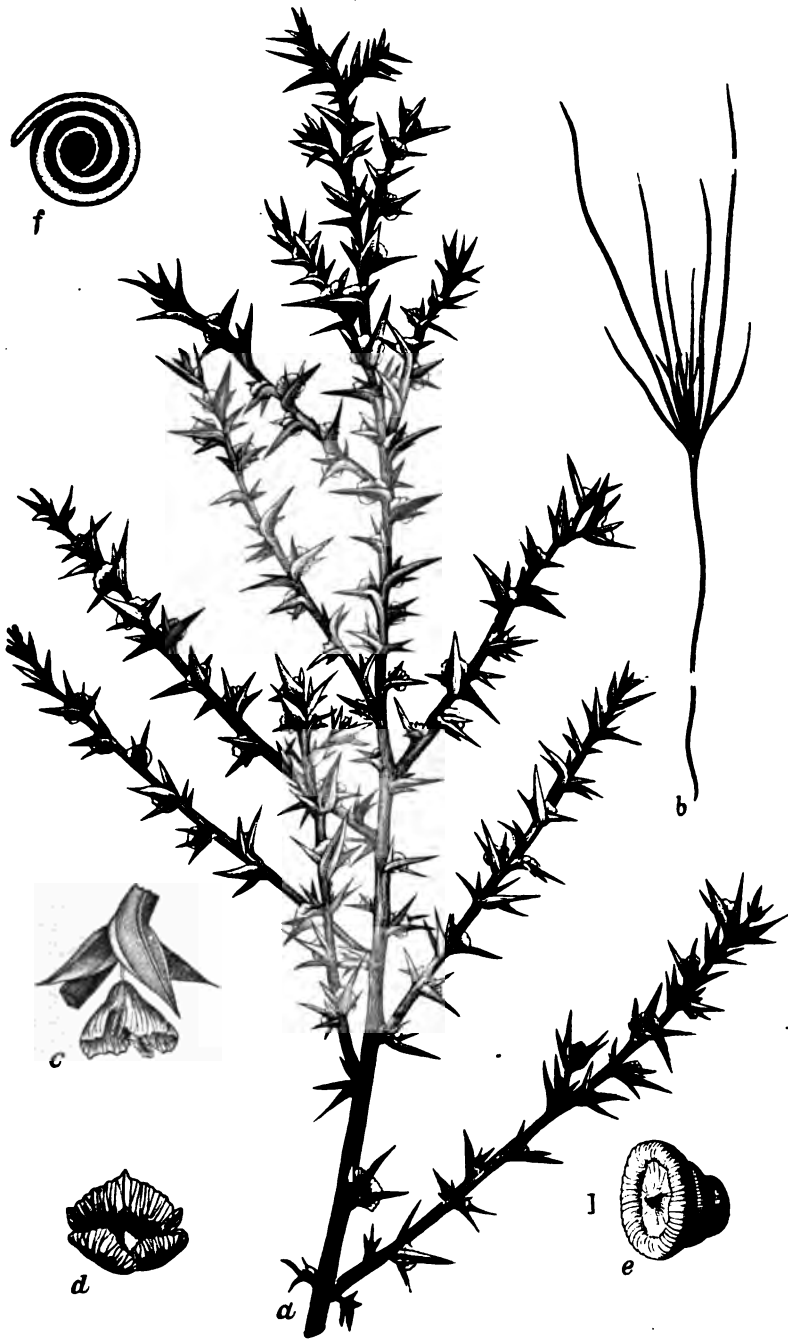


PLATE II.—RUSSIAN THISTLE. Detail figures. For references see description in text. (From Bulletin 15, U. S. Dept. of Agriculture.)

DESCRIPTION.

Technical description is purposely omitted, for I take it that those who are particularly interested wish simply the easiest method of recognizing it. To this end I give the following excellent popular description by Mr. L. H. Dewey, as given in the bulletins to which I have previously referred. The detail figures in Plate II, from the same source, and plates* I and III, will enable any careful observer to recognize the plant.

"In May and June the seeds germinate, each sending up on a slender red stem two narrow green leaves about an inch long and somewhat similar in appearance to shoots of grass. Between these seed leaves a short stem soon appears bearing slender spine tipped leaves, which later produce branches in their axils (Plate II, Fig. b). * * * Until dry weather begins the plants grow rather slowly, but they store up an abundance of moisture in the succulent leaves and branches. During the dry weather in August the moisture disappears from the slender leaves and they wither and sometimes fall off. New shoots are formed which at first are short and densely crowded with spine pointed leaves less than half an inch long, but later elongate so that the leaves become separated at intervals of one-sixteenth to one-half inch (Plate II, Fig. a). Each leaf is accompanied by two bracts similar to the leaf itself, all spine tipped and projecting at almost right angles to the stem. A single, small, stemless flower grows in a cup-shaped depression formed by the bases of the two bracts. The outer parts, or perianth, of the flower are thin and paper-like in texture, spreading, when fully open, about one-fourth inch, and are usually bright rose color (Plate II, Fig. d). If the flower is taken out and carefully pulled to pieces a small, pulpy, green, coiled body appearing like a minute, green snail shell will be found (Plate II, Fig. f). This is the embryo or miniature plant. As the seed ripens its coat becomes of a dull gray color, and at maturity the whole seed is about one-sixteenth of an inch in diameter, irregular in form, and of about one-half the weight of a flax or clover seed (Plate II, Fig. e).

During August and early September the plants become rigid throughout and increase rapidly in size, often growing 2 or 3 feet in height and 4 to 6 feet in diameter, forming a dense, bushy mass of spiny branches (Plates I, III, and Plate II, Fig. a). By the middle of September the exposed parts of the plants have usually changed in color from dark green to crimson or rose red. When the ground is frozen in November the entire plant, except the seed, dies. The root is broken by

*The frontispiece, Plate I, has kindly been loaned to this Station by the Ohio Station and for the use of Plate III we are indebted to the Wisconsin Station.

the force of the wind and the plant is blown about by the wind as a tumbleweed."

ITS PERNICIOUSNESS.

The Russian Thistle has no good points worthy of consideration. Some claims have been made for it as a forage plant, but its value in that direction should have no weight whatever when it is understood that it has no advantage over many others with no noxious qualities. It cannot be eaten by stock on the range except during the summer months (June and July), when other palatable feed is abundant.

In cultivated grounds it is a weed first, last, and all the time, robbing the soil and crowding out the crops. This is especially its history in grain fields, where it not only greatly reduces or exterminates the crop, but greatly impedes the process of harvesting, damages the machinery, and injures the horses' legs to such an extent as to form festering sores.

The large, rigid plants greatly interfere with all farm operations, and the dry plants, when banked against fences, corrals and stock yards offer inviting pathways for chance fires.

METHODS OF CONTROL.

It is an annual, hence if plants are not allowed to produce seed it will soon be brought under control.

It is not difficult to kill ; if plowed completely under or if cut down with a hoe it dies ; if mowed off below all of its branches at proper times it will suffice. If cut or mowed after blossoming the seeds are often matured from the sap of the somewhat succulent stems, hence all plants approaching maturity must be burned to make sure that they will not distribute any seed.

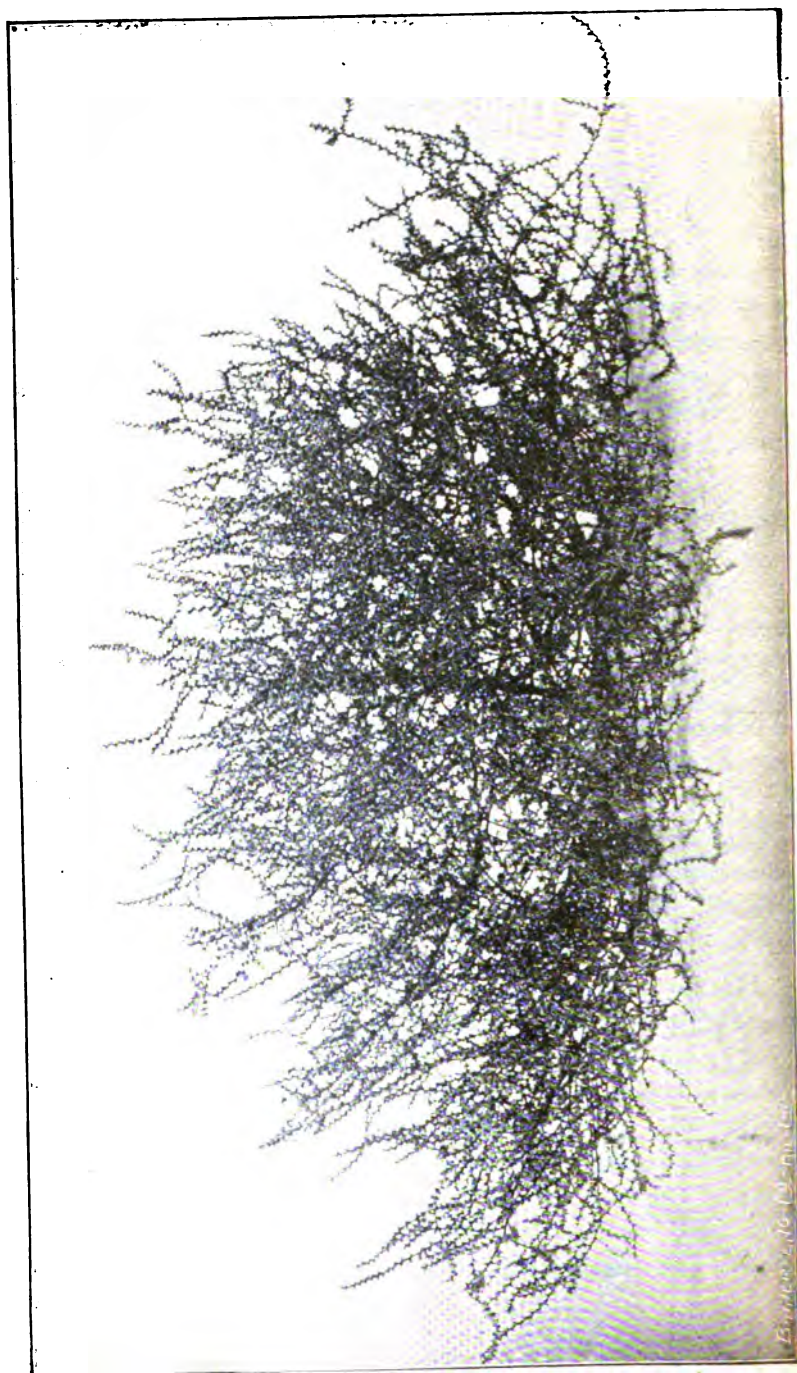


PLATE III.—RUSSIAN THISTLE. Usual form.

Cirsium discolor (L.) Moench.

As it is rather inconspicuous when young, but develops rapidly and to such enormous proportions late in the season, cultivated, and in fact all suspected areas need to be gone over in late August or early September to see that no isolated individuals have been overlooked.

Vigilance, and the free use of the plow and harrow, the hoe and the scythe, will soon rid a farm of it, but unless there is the completest co-operation of all the residents of a community the ground will soon be re-seeded again. It is just as essential to its extermination that my neighbor shall destroy them on his place as that I destroy them on mine. This will not happen till we have a thoroughly aroused public sentiment, backed by a just and enforceable law. To secure this sentiment it should only be necessary to make thoroughly known the character of the weed and the dangers that it threatens, and to furnish means for its recognition. On these points it ought to be made impossible for any one to remain in ignorance. As Mr. L. H. Dewey has said*, "make the pupils in the schools familiar with it, teach them to destroy it, as they would a rattlesnake, wherever they see it." Let the watchword be : "*Kill it.*"

When it is known that in some counties in our neighboring States this pest is in such complete possession that many farmers are abandoning their fields in despair, and that farm valuations on account of it are greatly diminished, it ought to spur us all on to secure its extermination in Wyoming while it may yet be within our control.

*Farmers' Bull. No. 10, U. S. Dept. Agriculture.

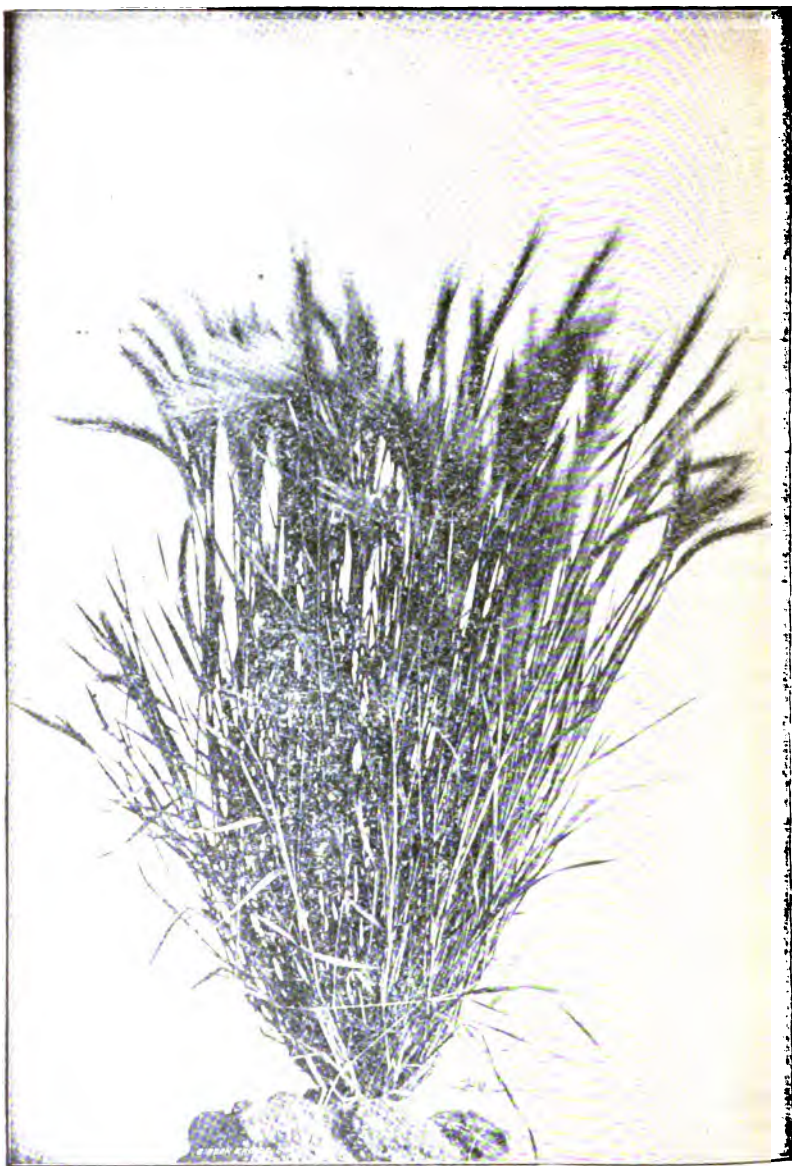


PLATE IV.*—SQUIRREL-TAIL GRASS (*Hordeum jubatum* L.)

*This excellent plate, as well as plates V, XI, XII and XIII, we are able to present through the kindness of Prof. Chas. S. Crandall, Botanist of the Colorado Station. The weed conditions of the two States are so similar that we were glad to avail ourselves of the excellent work that had been done for Bulletin 23 "Colorado Weeds," in which these plates first appeared.

SQUIRREL-TAIL GRASS,

Fox-Tail, Wild Barley (Hordeum jubatum L.)

In a State where hay forms so staple and important a crop as in Wyoming, the worst weed of our meadows must receive attention. In the opinion of the writer there is no one weed that so much concerns hay producers and hay users as this. Not because it is ever likely to take complete possession of our lands, as the Russian Thistle threatens to do, but because, so long as it is endured in our meadows, much hay must be quite unfit for use. How any one who knows its worthless character and the injuries that it inflicts upon stock can for a moment think of using hay in which it is found in any appreciable quantity, is incomprehensible. Selfish interests, as well as humane considerations, forbid its use.

This annual grass is, as soon as it heads, a pest and only a pest. Its light seeds, armed with the long barbed bristles, are carried everywhere by the wind, in the waters of our irrigating ditches and on our streams, and even by animals in their hair and wool.

With such easy dissemination the plant readily spreads to all fields where suitable conditions are offered. Unfortunately suitable conditions are often unwittingly created by the ranchman himself. By over-irrigation, particularly during the spring months, the native or cultivated grasses are wholly or partly killed out and the vacated soil is promptly occupied by this hardy indigene.

Being an annual it is not so very difficult to bring it under control. Infested meadows may be cut before the Squirrel-Tail heads, and if they are cut a second time during the season this will practically exterminate it, if fence

corners and turning rows are not maturing plants for the re-seeding of the ground.

Where it is in complete possession of a meadow the safest and best means is to break up the ground and plant to a cultivated crop for a year or two. This is always effective and probably the shortest road to a well-sodded meadow again, for the considerable presence of this weed in any field indicates that the better grasses have run out.

In this State there are many valuable meadows of native grasses which are being ruined by injudicious methods of irrigation. Constant flooding drowns out the better grasses, which are then replaced by seeds and rushes, or, worse yet, by Squirrel-Tail Grass. It is to be hoped that more judicious methods may prevail, and that the remarkably nutritious native grasses may still be saved in many meadows.

No description of this is needed ; it is known to all, or if not, may easily be recognized from the accompanying plate.

More complete information as to the structure, the mode of dissemination, the injuries resulting from this weed and the best methods of exterminating it, can be obtained from a bulletin by the writer*, No. 19 of this Station, and from one by Prof. L. H. Pammel†, of the Iowa Station.

COCKLE,

Cow Herb (Saponaria vaccaria L.)

Cockle is known to all the farmers of this State by name at least. Many have learned to know it at sight by reason of much bitter experience. This is at present the

*Squirrel-Tail Grass (Fox-Tail), One of the Stock Pests of Wyoming.

†Bulletin No. 30, Expt. Station, Ames, Iowa.



PLATE V.—COCKLE (*Saponaria Vaccaria* L.)

worst weed in grain fields. In cultivated fields it causes very little trouble, as it is as readily destroyed as other weeds; but in fields of spring wheat, especially, much damage is done by this plant. Springing up with the wheat the latter is crowded out, shaded out, and robbed of the food it might otherwise get from the soil. The result is a greatly reduced crop of inferior quality.

Like most of our bad weeds it is an introduction from Europe, but it is so well established now in this country and in the wheat growing sections of Wyoming that where it came from is only of historical interest. How to keep it out of our grain fields is a practical question, and I think one which can be answered.

This is a case where prevention, rather than cure, must be sought. A field well seeded to Cockle, as well as wheat, is practically beyond redemption. The remedy lies in clean seed on clean ground. This is not so difficult of attainment as many suppose. Suspected seed wheat, if it must be used, should and can be cleaned by screening. This should be sown on clean ground. Let the ground known to be full of Cockle seed be used for cultivated crops till the Cockle has been exterminated. To avoid having to fight and endure loss from it every year see that road sides, fence rows and vacant grounds are not maturing plants and seeds to undo all your other work.

This annual may be known by its smooth, opposite leaves, united by their bases, by its rather large pink flowers in a strongly five angled calyx which becomes much enlarged in fruit. It usually grows 18 inches to 2 feet high and branches above.

These characteristics in connection with the figure of

it (Plate V), will enable any one to determine suspected plants.

CANADA THISTLE,

(*Carduus arvensis* Robs.)

This is one of the true Thistles and not merely one in name. It has been talked of and written of for years throughout the United States, and as a result it has come to be so dreaded that wherever it has appeared relentless war has been waged upon it. This, however, has not exterminated it, but it has kept it in check. That this commendable vigilance against this foe might not relax, many States have placed this in the list of weeds proscribed by law; in fact, it was among the first, if not the first, against which laws were enacted.

This weed is now in Wyoming. The writer found a patch in a stock yard on a farm near Sheridan in July of this year. It was also reported from there, with specimens, in 1895. It is probable that some effort was made to exterminate it at that point, but it is very probable that it has entered the State at other places.

Every one should be on the lookout for this invader, as it is comparatively easy to dig out a few, but when a large area is infested it is a costly undertaking. I use the words *dig out* advisedly, for it cannot be destroyed by ordinary methods.

It is a perennial plant; that is, it lives for a number of years, dying down to the ground only, each year. It is reproduced by seeds, which are furnished with a tuft of hair, that the wind may the more readily carry them long distances. This accounts for the rapidity with which it

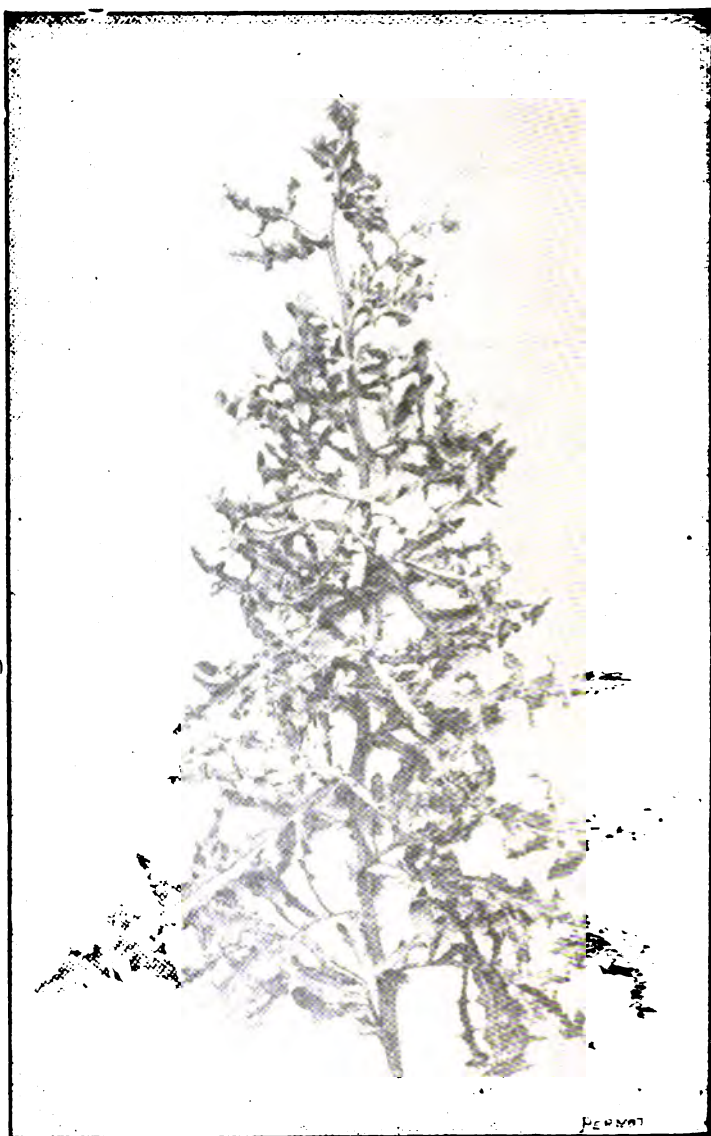


PLATE VI.—CANADA THISTLE (*Carduus arvensis* Robs.) Entire plant, showing habit of growth.

spreads, but the difficulty of killing it out where it has become established is quite another matter. Examination reveals the fact that each plant is furnished with a number of long, slender, underground stems, which at intervals give rise to new above ground stems. This, then, is a second means of reproducing the plant, and gives it its well-known tenacity of life. Ordinary stirring of the soil only increases the number of individuals, as each piece of the broken up underground stems promptly sends up a new shoot.

It can be destroyed. The first rule is that it must not be allowed to seed, otherwise new areas will be infested by the seeds blown away by the wind. To destroy

it where established, if the area be large, recourse must be had to some method of cultivating the soil which shall entirely keep down the above ground parts, thus starving to death the underground stems. All underground parts,



PLATE VII.—CANADA THISTLE. Part of a plant, showing leaf and head more in detail.

while capable of living for a time without food, ultimately require food prepared for them in the leaves of the plant. Any method then which shuts off this source of supply will be effectual. Repeated plowing may be depended upon, but only an occasional stirring of the soil, especially if the ground be wet, is of advantage to the weed.

In small areas dig them out entire, smother them by building stacks over them, or keep them cut below the surface for a season, or two if necessary.

That all may recognize this weed and attack it at once wherever it appears, two figures are given, one (Plate VI*) showing the plant entire, and the other (Plate VII†) showing some of the heads more in detail.

It grows two feet or more in height, is usually green and smooth, with weak prickles upon the margins of its lanceolate leaves. It branches freely, producing numerous, rather small (one-half inch) heads with rose purple flowers. It may be known from the Bull Thistle, described next, by its underground stems and by the absence of wing-like margins on the stem and of cottony wool on the under surface of the leaves.

BULL THISTLE,

Common Thistle (Carduus lanceolatus L.)

This large, common, roadside Thistle must be familiar to every one. It also has come to us from Europe, and, like the Dandelion, almost keeps pace with civilization. It is introduced into new areas chiefly in seeds, grains, hay, and the packing materials of goods imported.

*Through the courtesy of the officers of the Oregon Station we are able to present this plate of the Canada Thistle, as well as the two of the Bull Thistle.

†For the use of this plate we are indebted to the Illinois Station, as we are also for Plates X and XV, used in this bulletin.

Those not familiar with it may know it by the following description* and figures (Plates VIII and IX).

"It is a biennial, producing the first year simply a tuft of large, spiny leaves spread out flat upon the ground ;

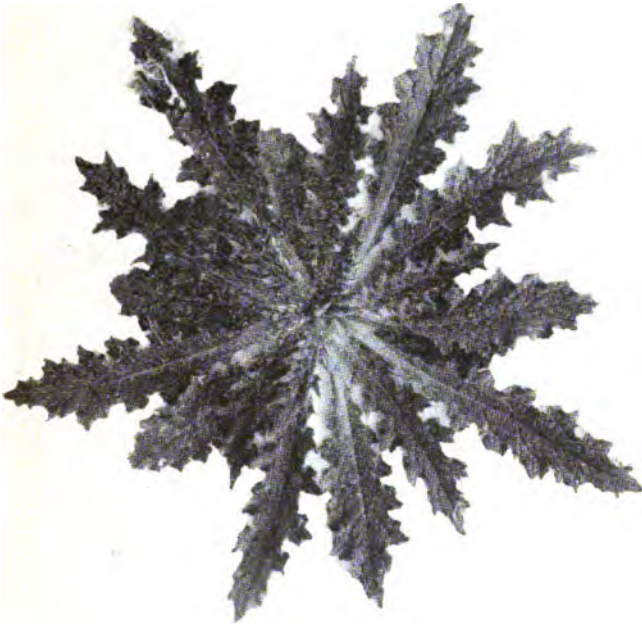


PLATE VIII.—BULL THISTLE (*Carduus lanceolatus* L.) Plant as it appears during its first year's growth.

the second year it sends up a stout, erect, branched stalk, two to four feet high, blooms, bears seed and dies. It may be distinguished from the Canada Thistle by the large flower heads (1 to 1½ inches in diameter), and the wider, stemless leaves, cobwebby beneath, with margins running down the stem as ragged wings, which make the stalks very prickly."

*By Prof. Moses Craig, in Bull. 32 of Oregon Station.

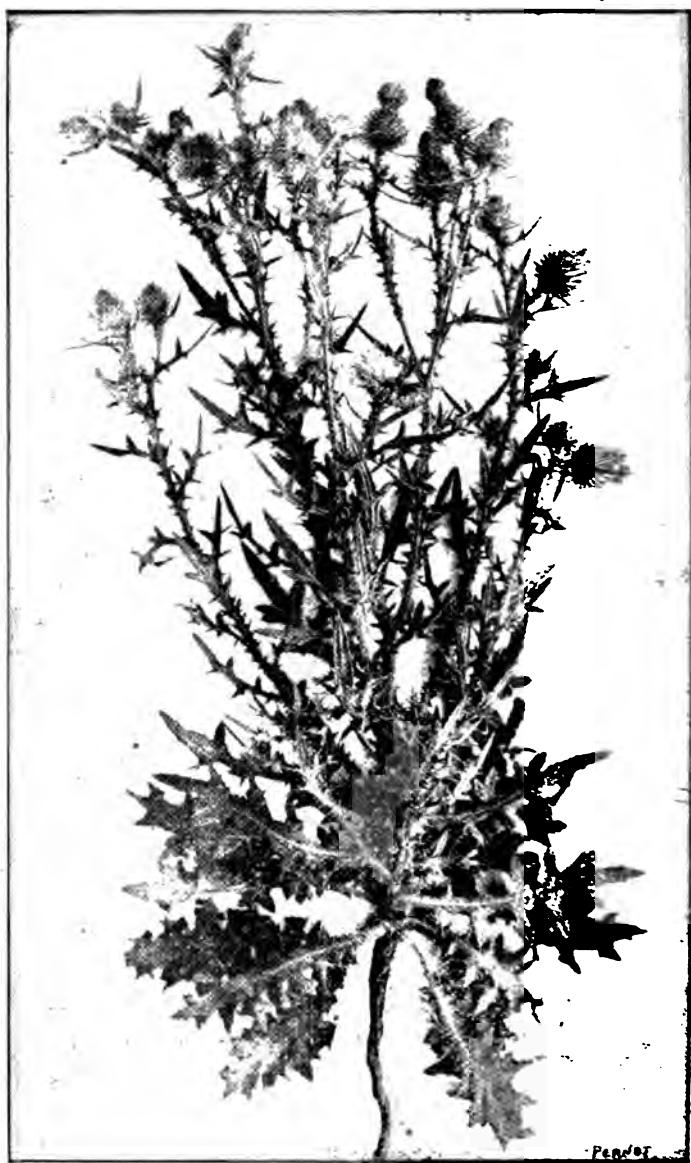


PLATE IX.—BULL THISTLE. Mature plant as it appears the second year.

This Thistle is not so difficult to exterminate as the Canada Thistle, and if no plants were allowed to seed for two years the work would be done. The plants are themselves readily killed, for if cut below the short crown they rarely come up again. This can be done quickly with a tool called, by Mr. L. H. Dewey, a spud*. This is a chisel shaped tool with a long handle. The writer has found a carpenter's stout, narrow chisel effective, but more rapid work could be done with a heavier tool on a long handle. A single thrust ought to suffice to cut the largest plant two or more inches below the surface.

The weed gives no trouble in cultivated ground, but often becomes a nuisance of the worst sort in pastures. The large rosette of leaves and the spreading branches, with their long, formidable spines, not only reduces the productive power of the land, but renders unavailable the grass that does grow, for few browsing animals venture to contest with the Bull Thistle its pre-empted area.

It also springs up along roadsides, in waste ground, and even in lawns, in all of which it produces a most slovenly and unsightly appearance. A few weeds left to fruit in such places will render of no avail what has been done in the field; the wind catches the seed with its tuft of hairs and whirls it along, possibly for miles, and the new crop of course proves just as troublesome as the first.

*See Farmers' Bulletin No. 10, U. S. Dept. Agriculture.

WILD OR PRICKLY LETTUCE,

Compass Plant (Lactuca Scariola L.) Plate X.

Once more Europe has furnished a most vigorous but insidious foe. Though introduced into this country nearly a quarter of a century ago, it is only within the last few years that this tramp has attracted universal attention. In some respects a rather inconspicuous plant, it established itself everywhere before it came under the ban. It is even more widely dispersed than the Russian Thistle, for it has spread from ocean to ocean. In Wyoming, however, it is still rare, only one patch having been observed, viz: on the Cheyenne and Northern, in the Platte Canon. In many other States it has become so abundant that its extermination is no longer considered a possibility*.

It should be an easy matter in Wyoming, where it has no serious foothold as yet, to keep this pest in complete control. It is an annual weed, no more difficult to kill than most annuals, except for the large number of seeds so widely dispersed by the wind.

Prevention of seeding is the remedy, and if the plant is half so troublesome and unsightly as it is said to be elsewhere, the farmers of the State will do well to learn to recognize it. Let the first plants that appear be uprooted before any seeds are mature.

The following points are selected from Dr. J. C. Arthur's bulletin, already cited.

"It is closely related to the garden lettuce, having many of the same characteristics, but with the edge and midrib of the leaf and the lower part of the stem beset with weak prickles. It blossoms in July and August.
* * *

Correspondents, and writers in the press unite

*See Bull. 52, Vol. V, 1894, of the Indiana Station, Dr. J. C. Arthur.



PLATE X.—PRICKLY LETTUCE (*Lactuca scariola* L.) Showing its usual form of growth; also its habit of sending out new shoots if cut off.

in considering this a prominent and disagreeable weed. The plant has many of the qualities of a successful intruder as well as an uncompromising weedy appearance. * * * It becomes an important portion of all weed patches. * * * When the top is injured sprouts are sent out from the base of the stem in a very troublesome manner. * * * The plant has a curious habit of twisting its stem leaves into a vertical position, with the edges directed north and south. It is one of two well marked compass plants. * * * Remember the persistent habit of the plant to throw out sprouts unless cut off below the surface of the ground. * * * A suitable weed law should exist so that dilatory land owners may be brought to action."

BUFFALO BUR,

Beaked Horse-Nettle (Solanum rostratum Dunal.) Plate XI.

We will now consider very briefly one of the native weeds which has in other places been very strongly condemned, viz: the Buffalo Bur. It has been observed in several places in the State, usually in sandy ground. From no locality has it been reported as a bad weed, and it is mentioned here chiefly because it has proven that it has weed qualities. It is travelling eastward from the western plains, and in spite of all precautions seems to be establishing itself victoriously in all of the Mississippi valley States. Since it has shown its qualities elsewhere it is just as well to give it no quarter here.

It is a branched annual, one or two feet high, with a rather large lobed leaf. It may be known by the stout yellow prickles which cover both stem and leaf; by the

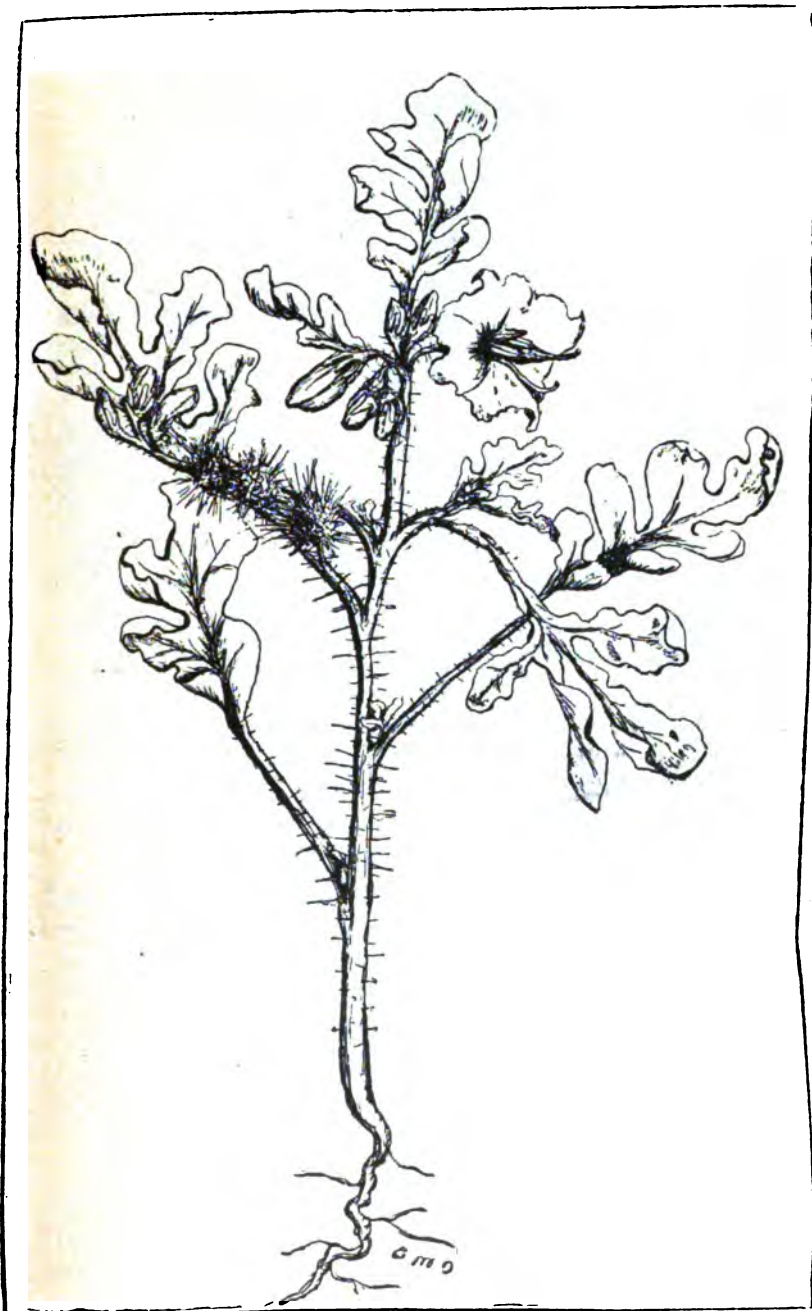


PLATE XI.—BUFFALO BUR (*Solanum rostratum* Dunal.) □ A small plant.

yellow flowers, nearly an inch across, shaped like the blossom of the tomato and potato, to which it is botanically related, and by the horridly prickly calyx which permanently encloses the fruit. The enlarged calyx with its yellow spines produces a bur-like effect, and explains the origin of its common name.

POVERTY WEED

(*Iva axillaris* Pursh.) Plate XII.

This is a bad weed to get rid of when once introduced, but fortunately it is not generally prevalent. It is a perennial, with running underground stems, the breaking up of which by plowing or hoeing only enormously multiplies the weed. It must be dug out entire or the root stocks starved to death by keeping down all leaves and stems. This can only be done by very frequent cultivation. Infested ground can also be cleared by smothering the weed with heavy seeding to grain or Alfalfa, or better yet, a close sod of the common meadow grasses.

It grows 6 to 10 inches high, branches somewhat and forms dense patches in favorable soil. In the axils of the oblong leaves are produced small, yellow, drooping heads, which produce a moderate amount of seed.

PERENNIAL FRANSERIA,

(*Franseria discolor* Nutt.) Plate XIII.

For this plant no common name is known to the writer, so Perennial Franseria may be adopted. Botanically it stands near the Ragweeds, as does also the Poverty



PLATE XII.—POVERTY WEED (*Iva axillaris* Furch.)

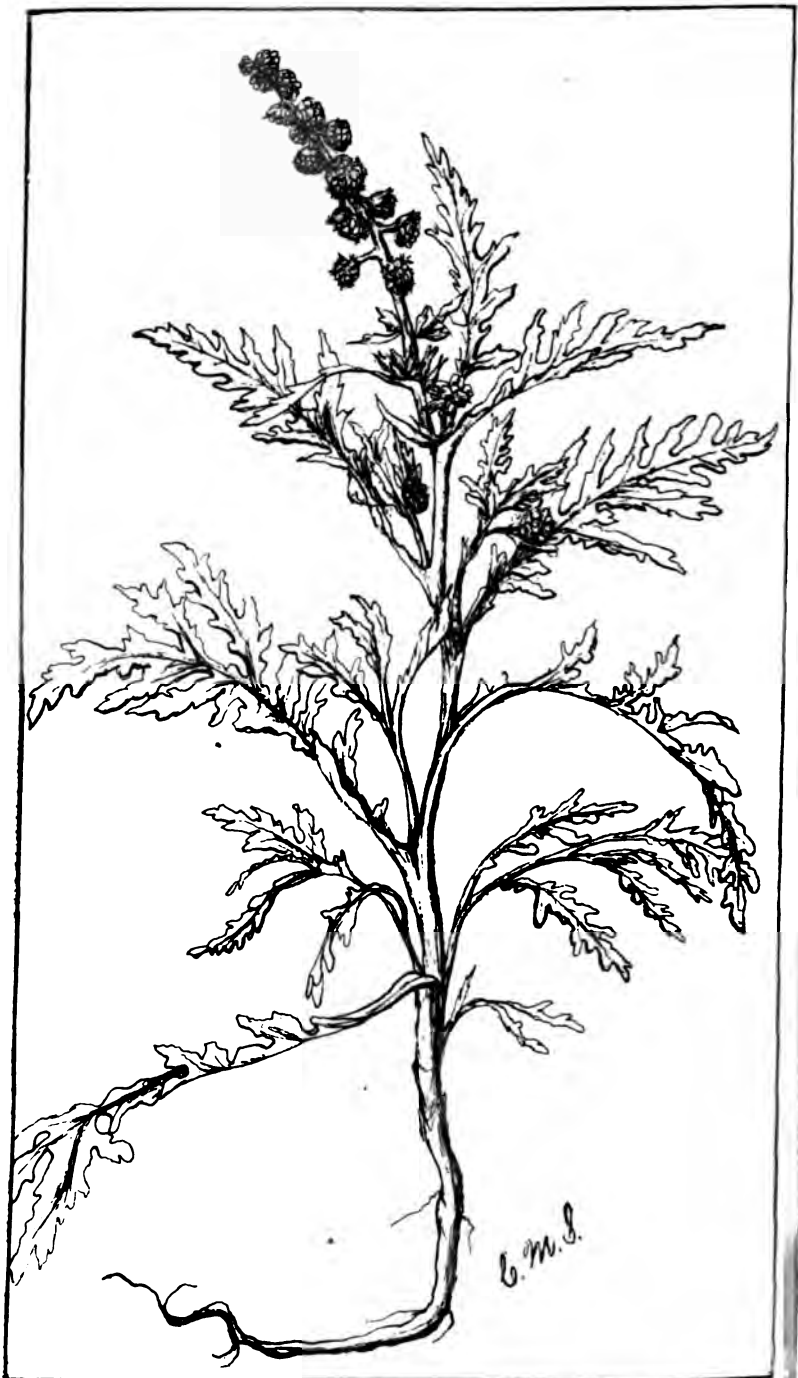


PLATE XIII.—PERENNIAL FRANSERIA (*Franseria discolor* Nutt.)

Weed. Like the Poverty Weed, it is a perennial, and may be compared to that in its mode of life and reproduction. It is more common in the State and still more difficult to eradicate, as it adapts itself to all soils. It has been reported from some localities as defying all attempts to remove it. It readily crowds out all garden or cultivated crops unless hand weeding is repeatedly resorted to. The same methods for its control as for Poverty Weed are suggested. The accompanying plate shows two characteristic plants. They usually grow so densely, however, as to cover the ground as with a mat, and are 4 to 6 inches high. The flower stock overtops the dissected leaves, which are green on the upper surface and whitish beneath.

Another species of this genus (*Franseria Hookeriana* Nutt.), is common in sandy soil, but has not been reported as a weed. It produces a very spiny bur-like fruit.

THE PIGWEEDS

(*Amaranthus*) Plates XIV and XV.

The Pigweeds, of which there are several species, are found in nearly all cultivated grounds throughout North America. Originally the forms that are now commonest were confined to tropical and western America. These are Thorny Amaranth (*Amaranthus spinosus* L.), Common Pigweed (*Amaranthus chlorostachys* Willd.), Rough Amaranth (*Amaranthus retroflexus* L.), Low Amaranth (*Amaranthus blitoides* Wats.), and Common Tumbleweed (*Amaranthus albus* L.). Only the last three of these are common in Wyoming, and the last two are indigenous. They are all annuals, and attract no particular attention

except in cultivated ground, where, if once established, they furnish seed enough each season for several bountiful crops successively produced, springing up afresh after each cultivation of the land.



PLATE XIV.—LOW AMARANTH (*Amaranthus Mitoides* Wats.)
A, Extremity of branch. B, A staminate flower. C, A pistillate flower.

Of the Rough Amaranth I am unable to present a figure, but it may be known from our other Pigweeds by its erect habit and short, thick, erect spikes, which are almost as long as the terminal one.

The Low Amaranth branches from the base, and has a decided spreading habit, being in many instances quite prostrate. Plate XIV* shows the end of one such branch. In several instances farmers have pronounced this their worst weed.



PLATE XV.—COMMON TUMBLEWEED (*Amaranthus albus* L.) This is the plant most frequently mistaken for the Russian Thistle.

The Common Tumbleweed is frequently mistaken for the Russian Thistle, which it closely resembles in form. It may, however, be easily distinguished, for this has flat leaves, the Thistle never has; this has no spines, the floral bracts only becoming somewhat prickly when dry. Plate XV† shows it as a well developed tumbleweed.

*From Bull. No. 21, Nevada Station, through the kindness of Prof. F. H. Hillman.

†This, as well as Plate X; originally appeared in Bulletin No. 39 of the Illinois Station, by the courtesy of whose officers we are permitted to present them here.

The remedy for all of them is clean seed and clean cultivation. Clean cultivation once inaugurated makes each successive year easier and easier. This self-evident truth applies to other weeds as well as the Pigweeds.

DANDELION

(*Taraxacum officinale* Webér.)

This is known to every one, and needs neither description nor illustration. It need not be considered as a weed but for the trouble it gives in lawns. Here it is pre-eminently the worst, for it establishes itself in even the most compact sod.

It is easily destroyed by destroying the lawn, but in Wyoming lawns represent too much time and labor to be sacrificed except as a last resort. It could easily be kept in control on individual lawns except for the crop on your neighbor's neglected lot and on the margins of the irrigating ditches in our streets. These furnish seeds enough, all with full spread sail, to re-establish the weed as often as you care to remove it. No remedy can be suggested except that each lot owner be urged or required to keep his own premises clear, including the streets and alleys adjacent to said lots. Until that is done there can be only eternal warfare and no respite from the service. When that is done the contest will soon be an easy victory for the lawn owner.

To remove this perennial from the lawn the best implement is a strong, but narrow (one-half inch) carpenter's chisel. With this the rootstock can be quickly cut some inches below the surface without injury to the grass. Unless cut low in the ground it comes up again.

Various remedies have been tried, such as salt, coal oil, etc., applied to the cut rootstocks, but, besides being too much labor, it is unsatisfactory at best. Unless applied in large quantities it is not effectual, for the Dandelion is hardier than the crop, and large quantities, besides being expensive, kill the lawn as well as the weed.

Plants cut out when in bloom should be burned, for otherwise they even then mature their seeds and send them off on every breeze.

To those in other States who may read this I will state that in Wyoming the Dandelion has apparently found its most congenial home. It is here in full growth and blossom from early spring till late autumn.

A Half Century of Weeds.

While it does not seem best to consider any more of our weeds in detail at present, it may be worth while to make record of those that have attracted some attention within the State.

Enumerating first those already discussed without further comment, the others follow with the very briefest data*.

1. **Russian Thistle** (*Salsola Kali* Tragus Moq.)
2. **Squirrel-Tail Grass** (*Hordeum jubatum* L.)
3. **Cockle, Cow Herb** (*Saponaria Vaccaria* L.)
4. **Canada Thistle** (*Carduus arvensis* (L.) Robs.)
5. **Bull Thistle, Common Thistle** (*Carduus lanceolatus* L.)
6. **Wild or Prickly Lettuce** (*Lactuca scariola* L.)
7. **Buffalo Bur, Beaked Horse-Nettle** (*Solanum rostratum* Dunal.)
8. **Perennial Franseria** (*Franseria discolor* Nutt.)
9. } **Pigweeds** { Rough Amaranth (*Amaranthus retroflexus* L.)
10. } { Low Amaranth (*Amaranthus blitoides* Wats.)
11. } { Common Tumbleweed (*Amaranthus albus* L.)
12. **Dandelion** (*Taraxacum officinale* Weber.)
13. **Poverty Weed** (*Iva axillaris* Pursh.)
14. **False Flax** (*Camelina sativa* Crantz.)
 Troublesome in grain, observed but once, Parkman, July, 1896.
15. **Skeleton Weed** (*Lygodesmia juncea* Don.)
 Grain fields and cultivated grounds; perennial, dig it out, common.
16. **Wild Tomato** (*Solanum triflorum* Nutt.)
 Very annoying in gardens and truck patches; annual, prevent seeding.
17. **Dock, Sour Dock** (*Rumex salicifolus* Wienm.)
 In meadows, perennial, hard to eradicate; dig out, prevent seeding.

*For brief notes upon these and other weedy plants, as to locality, date of collection, etc., see Bull. 28, First Report on the Flora of Wyoming.

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18. **Purselane**, Pusley (*Portulaca oleracea* L.)
Becoming common in rich field and garden soil; Sheridan and Wheatland, July, 1896.
 19. **Common Crab Grass**, Polish Millet (*Panicum sanguinale* L.)
Troublesome in garden crops, perennial; "hit it with a hoe."
 20. **Great Ragweed** (*Ambrosia trifida* L.)
Margins of fields, fence corners and yards, unsightly; mow it.
 21. **Mallow** (*Malvastrum coccineum* Gray.)
Cultivated ground and door yards, perennial; dig it out.
 22. **Prickly Pear Cactus** (*Opuntia polyacantha*, several varieties.)
A nuisance on the range and in pastures; cultivation and water kills it.
 23. **Bur Grass**, Sand Bur (*Cenchrus tribuloides* L.)
Sandy ground; prevent seeding by clean cultivation.
 24. **Dodder** (*Cuscuta*, several species.)
Troublesome in Alfalfa and Flax; remedy, rotation of crops.
 25. **Green Fox-Tail** (*Setaria viridis* Beauv.)
In cultivated grounds; pull up and prevent seeding.
 26. **Sunflower** (*Helianthus annuus* L.)
Waste ground; plow under and prevent seeding.
 27. **Cockle Bur** (*Xanthium Canadense* Mill.)
Cultivated ground, southeastern part of the State, annual; clean cultivation the remedy.
 28. **Sow Thistle** (*Sonchus asper* Vill.)
Reported as spreading at Evanston; prevent seeding.
 29. **Yellow Flax** (*Linum rigidum* Pursh.)
Grain fields; rotation of crops, clean culture.
 30. **Hedge Bindweed** (*Convolvulus sepium* L.)
Still rare, Cheyenne; thorough late cultivation.
 31. **Wild Oats** (*Avena fatua* L.)
Not uncommon in oat fields; clean seed, rotation of crops.
 32. **Wild Buckwheat**, Black Bindweed (*Polygonum convolvulus* L.)
Common in grain fields and truck patches; clean seed and cultivation.
 33. **Lamb's Quarters** (*Chenopodium album* L.)
Common in all cultivated grounds; clean cultivation.

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34. **Ragweed**, Roman Wormwood (*Ambrosia artemisiæfolia* L.)
Laramie, Cheyenne, Sheridan; in grain fields and cultivated ground.
 35. **Bib Grass**, English Plaintain (*Plantago lanceolata* L.)
Reported only from Lander; clean seed and prevention of seeding.
 36. **Porcupine Grass** (*Stipa comata* Trin.)
An annoying and worthless grass.
 37. **Poison-Weed**, Larkspur (*Delphinium Geyeri* Greene.)
Very abundant in places. This is the plant which hungry cattle sometimes eat voraciously, in which case it often causes fatal bloating.
 38. **Loco**, Loco-Weed (*Oxytropis Lamberti* and its varieties.)
Very common, said to cause the peculiar mental disorder in horses known as "loco."
 39. **Gum Plant** (*Grindelia squarrosa* Dunal.)
Troublesome in lawns and meadows; prevent seeding.
 40. **Wild Mustard** (*Brassica sinapistrum* Boiss.)
Only single specimens observed. A bad weed, pull it out.
 41. **Shepherd's Purse** (*Capsella Bursa pastoris* Medic.)
 42. **Rocky Mountain Bee-Plant** (*Cleome integrifolia* T. & G.)
 43. **Wild Liquorice** (*Glycyrrhiza lepidota* Pursh.)
 44. **Stick-Seed** (*Echinopspermum Lappula* Lehm.)
 45. **Goose Grass**, Door Grass (*Polygonum aviculare* L.)
 46. **Perennial Ragweed** (*Ambrosia psilostachya* DC.)
 47. **Spanish Needles** (*Bidens frondosa* L.)
 48. **Marsh Elder** (*Iva xanthifolia* Nutt.)
 49. **Pepper Grass** (*Lepidium apetalum* Willd.)
 50. **Wormwood Sage** (*Artemisia biennis* Willd.)

Suggested Weed Legislation.

AVEN NELSON.

THE SITUATION IN WYOMING.

Wyoming has a weed law*. Is it effective? Let the facts in regard to the Russian Thistle and other weeds set forth in the preceding pages answer.

Wyoming needs some new weed legislation *now* if it is to be of the greatest possible service to the State. We may need such legislation more some years hence, just as he who is seriously ill needs a physician more than he who has the incipient stages of the malady. Prevention is always better than cure, but when a physician must be called the chances for the patient are better if he be called promptly. Vast sums of money are being expended in other States to cure an evil which is, so to speak, only at our threshold. Prompt action, with the expenditure of only a nominal sum, will do much to protect us against the weed foes which are just beginning to make themselves felt.

The notion has long prevailed that this is a grazing State solely, that the flocks and herds run on the open range, and that these, with the mines of our mountains, constitute our wealth. It is time for such notions to cease. Our agricultural interests have had a marvelous development. In some counties they are paramount, and in all equal to any other single interest.

The open range stock business, with its hazards, is

*Session Laws of 1895. Russian Thistle and Canadian Thistle are proscribed. No method is provided for bringing this fact before the people or the officers concerned; neither are any means suggested by which these plants may be recognized. The act is printed in full at the close of this bulletin.

giving place to more conservative methods. Smaller, but more numerous herds, individual rather than company ownership, pastures accessible from the ranch or farm, hay and feed during severe weather, are changes which are placing this interest upon a safe business basis. As this comes to be the status of affairs, farming, with all that that implies, is inseparable from it. Let our mines develop beyond the expectation of the most sanguine, our agricultural interests, in the inclusive sense of the term, must yet be the source of much of our wealth. In this vast empire of 100,000 square miles there are other interests than those of the mines and the old time range stock business. Let him who doubts this visit the different counties, and he will see many prosperous and happy homes on well kept farms. The prosperity of our farmers is inseparable from that of the State. Let their interests be conserved by legislation which will not leave them to fight their weed foes unaided. Several lines of railroad are operated within the State, and it is to be hoped that we shall soon have more. Inseparable adjuncts of civilization as they are, they are also, for reasons previously stated, the principal means for the introduction of new weeds into the State. Let it be said, however, to the everlasting credit of railroad corporations, that they have shown themselves more ready to comply with the spirit of weed laws than have many individual citizens. It is hardly to be expected, however, that said corporations will concern themselves with what is never called to their attention.

The danger points at present are not the ranches and farms, but the right of way of the railroads, our public highways, and especially the vacant grounds in our towns and cities. All of these danger points may be guarded if

the matter is officially brought to the notice of the parties concerned.

LEGISLATION.

It may be objected that with so much unoccupied territory weed laws cannot be enforced, but as I have endeavored to show it is not the unoccupied territory that is the source of danger. It is this unoccupied territory, as well as our fields and farms, that we would protect.

No one thinks for a moment that weeds can be legislated out of existence, but there are two or three of foreign introduction that the State as a whole is interested in repressing, and that, by united action, can be kept in subjugation. Grain growing communities cannot afford to admit the Russian Thistle, neither can those who are interested in pasture and range grounds afford to permit its occupancy of these.

A large majority of the States and territories have laws relating to certain weeds. Every year of late sees one or more of those without such legislation falling into line. No State has ever repealed such legislation except to substitute more timely acts for those repealed. Judging by these facts one infers that such laws have been found profitable elsewhere. This State needs such safeguards more than the compactly settled commonwealths.

Mr. L. H. Dewey, Assistant Botanist to the Department of Agriculture, has for several years been studying the weed question in all of its aspects. The weed legislation of the several States has come in for its share of attention. He has personally investigated the operation of said laws in respect to the objects sought to be attained. After such study of the whole subject he has published*

*Legislation Against Weeds, Bulletin No. 17, Div. of Bot., U. S. Dept. of Agriculture.

"a form which outlines the essential provisions of a general State weed law."

This form seems to embody all that is practical in this line of legislation, and has received the endorsement of the chief officials of the Department of Agriculture*.

Taking this form as a basis, and modifying it so as to adapt it to the conditions in this State, having respect all the while to the fact that the expenses attendant upon such a law must be reduced to the minimum, the following form is respectfully recommended to the Legislature of this State for its consideration as a substitute for the present law upon the subject†.

AN ACT FOR THE EXTIRPATION OF SUCH WEEDS AS ARE
MOST INJURIOUS TO THE AGRICULTURAL INTERESTS
OF THE STATE OF WYOMING :

Be it enacted, etc. :

SECTION 1. A permanent commission, to be known as the State Weed Commission, is hereby created, to consist of the Professor of Botany of the University of Wyoming, who shall be known as the State Botanist, and three eminent farmers or ranchmen, who shall be appointed and commissioned by the Governor, with the consent of the Senate, from among the farmers or ranchmen who may be members of the Legislature during the two years following such appointment. They shall hold their offices for a term of two years, or until their successors are appointed. The Governor shall have power to fill all vacancies that may happen in the commission during the recess of the Senate, by granting commissions, which shall expire at its next session‡.

*I quote from the letter of transmittal of the bulletin cited : "I have pointed out in my annual report for 1894 the fact that, since the total value of our principal field crops for the year 1893 was \$1,760,489,273, an increase of only 1 per cent., which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of about \$17,000,000 during that year alone. The passage of effective weed laws, like the one outlined and discussed in this report, is of the first importance in dealing with this problem." This letter was signed by Dr. Frederick V. Coville, Chief of the Division of Botany, and directed to the Hon. J. Sterling Morton, Secretary of Agriculture, who undoubtedly approved of the publication of the bulletin under consideration.

†The original form, of which this is largely a copy, "was carefully revised by a jurist familiar with legal usages and constitutional requirements."

‡For full explanation of each of these sections, with reasons for their several provisions, see the bulletin previously cited. The reason for the suggested composition of the commission is as follows : "The technical knowledge of the botanist and the practical knowledge of the farmers on the commission are needed together to decide what ought to be done and what is really practicable."

SEC. 2. Said commission shall meet biennially at the Capitol on the next week day immediately following the adjournment of the Legislature, and shall be in session for a period not exceeding two days; and for such service each commissioner, who is not a salaried officer of the State, shall be entitled to be paid dollars a day for each day's actual attendance at the biennial session; said compensation and the necessary expenses of the commission for stationery, printing and postage shall be paid by the State Treasurer out of any moneys in the treasury, not otherwise appropriated, upon vouchers issued by the secretary of the commission and approved by the chairman.

The members of the commission being members of the Legislature, the short session at its close will not impose upon them any serious hardship, and the cost to the State will be only nominal.

SEC. 3. The Governor shall, when necessary, assign a room at the State Capitol for the use of the commission in which to hold its biennial sessions. Three commissioners shall constitute a quorum. The State Botanist shall be custodian of the records, and, when present, be chairman of the commission.

SEC. 4. Said commission, or a majority thereof, shall determine during its first session what species of weeds, not exceeding three in number, are most injurious to the interests of the State, and shall prepare a list thereof, to be known as Schedule A of this act, which shall state the common and technical names of such weeds and the time or times of year at which they can be most advantageously destroyed, and shall contain a concise description of the best economical methods for their destruction. Said schedule may thereafter be modified at any biennial session of the commission by a majority thereof: *Provided*, That not exceeding the above number of species of weeds shall be included in any biennial schedule.

SEC. 5. When, at its first session, or at any biennial session thereafter, the commission shall have adopted a schedule, or shall have modified one previously adopted, as above provided for, it shall be the duty of the chairman to have a sufficient number of copies of this act, with such schedule annexed, printed and distributed by mail in the following manner: One copy to each State, county and township officer, and one copy to each daily and weekly newspaper published within the State; and the schedule so adopted or modified shall be published in the same manner as the public statutes are published.

"The thorough advertisement of weed laws will do much to secure their observation. Unlike criminal laws, which apply chiefly to men who have little respect for right and justice aside from the fear of penalty, the weed

laws apply usually to men who obey the laws without compulsion by the courts, and in most cases a knowledge of the law will be sufficient warning to enforce its provisions. Copies should be sent to agricultural and other papers for publication, so as to disseminate a knowledge of its provisions as widely as possible among the people."*

SEC. 6. It shall be the duty of every owner, lessee, or occupier of land in this State, and of every owner, lessee, or occupier of any city, town, or village lot, upon whose land or lot any of the weeds named in the schedule provided for in this act shall be found growing, to destroy the same or cause them to be destroyed at or before the time or times mentioned in said schedule, and in the mode therein described, or in such other manner as shall absolutely prevent the ripening and spread of their seed.

"In nearly all cases the land owner can do this work at much less cost than it can be done by the public authorities, and in arable fields it can usually be done in the ordinary operations of cultivation."

SEC. 7. The city marshal in incorporated towns and cities, and the road supervisor in each county are hereby constituted weed inspectors for towns and cities, and for the county outside of such towns and cities, respectively.

SEC. 8. In case of the neglect or failure of any owner, lessee, or occupier of any land or lot within this State to destroy thereon the weeds mentioned in Schedule A at or before the times mentioned in said schedule, any person owning or having in charge any land or lot within the same township may complain in writing, stating the names of the weeds, the location of the land, and the name of the owner, to the road supervisor or the officer having in charge the highways or streets of the township, city or village within which the weeds complained of are growing. In every such case the complainant shall send with his complaint a written agreement to pay the said highway commissioner or other officer above designated his reasonable expenses incurred in the inspection of the land complained of on which any of the weeds mentioned in the schedule are not found. Upon the receipt of such complaint it shall be the duty of said road commissioner, or other officer, to inspect the land or lots mentioned in the complaint, and if any of the weeds mentioned in Schedule A are found growing thereon he shall notify the owner, lessee, or occupier of the land in writing to destroy them, and if the weeds are not destroyed at the expiration of five days after service of notice, he shall employ such labor as is necessary and enter the lands and destroy

*The comments following Sections 5, 6, 10 and 12 are also by Mr. Dewey.

in the most practicable and economical manner (or in the manner prescribed in the schedule) all of the weeds mentioned in the schedule that are found growing thereon: *Provided, however*, That in case there is no resident owner, lessee, or agent responsible for the care of the land the service of notice may be omitted.

SEC. 9. Each road supervisor or other officer, designated in Section 7, shall make an itemized statement, duly verified by oath or affirmation, of the expenses incurred in inspecting each tract of land or lot on which weeds mentioned in Schedule A were found growing, and of all expenses incurred by him for destroying said weeds, which statement shall contain a description sufficient for identification at the office of the county assessor of each tract of land or lot on which such weeds were destroyed under his direction, together with the name of the owner, lessee, or occupier of said tract of land or lot, and he shall deliver each such statement to the county assessor, and a certified copy thereof to the county clerk. He shall also issue vouchers for himself in inspecting weeds, at the rate of dollars per day, and to each laborer employed in destroying weeds at the rate of dollars per day, for the time actually employed. These vouchers shall be presented to and audited by the county clerk, who shall indorse thereon the amount he finds due, and then they shall be returned to the payee named therein, or his assigns, or legal representatives, and be paid by the county treasurer out of any moneys not otherwise appropriated, or they shall be receivable for county taxes within the county in which they were issued, to the amounts indorsed thereon by the clerk.

SEC. 10. The county assessor shall assess a special tax on each lot or parcel of land on which weeds have been destroyed by the officers, as above directed, the amount of expenses incurred for inspection and in the destruction of the weeds, as set forth in the verified expense statement received from the inspector. Said taxes shall be collected in the same manner and with like penalties as other county taxes are collected: *Provided, however*, That the owner, lessee, or occupier of any land or lot in respect to which any such expense statement has been issued, may deposit the amount payable thereon with the county treasurer, and in each such case it shall be the duty of the treasurer to receive the same and give notice of the payment to the assessor.

“The expenses of destroying weeds should be paid eventually by the land on which the weeds were destroyed. It would evidently be unjust to pay them from funds raised by the community, and such a method would create a temptation to have one's weeds pulled at the public expense. To assess persons with the costs, or to punish by fine or imprisonment, involves litigation and per-

sonal difficulties that often cause the law to be inoperative."

SEC. 11. The State Weed Commission shall have power to prepare and issue all necessary printed forms, notices, and instructions, tending to secure uniformity in employment of labor, statements of expenses, and the rendering of reports.

SEC. 12. Each road supervisor shall, in December of each year, mail to the State Botanist a report in the prescribed form, stating approximately the number of acres in his district on which weeds of each species mentioned in Schedule A were destroyed under his direction during the preceding part of the year, the total cost of destroying them, and the cost of inspecting the land in his district. The State Botanist shall present to the Governor on the first Monday in February in each year, a report of the proceedings of the commission, together with a statement of its expenses, and of the total expenses by counties of inspecting land and destroying the weeds thereon during the preceding year, and of the total number of acres in each county on which weeds have been destroyed as required by this act. And it shall be the duty of the Governor to submit said report to the State Legislature, if then in session, or within the first week of its next regular session.

"A report such as is here proposed will require comparatively little time in compilation, and will aid materially in deciding how much is being done under the law toward the eradication of weeds. It will afford data needed to determine approximately how much the benefits derived from enforcing the law exceed the cost."

SEC. 13. The wilful resistance to, or wrongful interference with any weed inspector or assistant, or laborer employed by any weed inspector, while in the performance of any of the duties in this act prescribed, is hereby declared a misdemeanor, punishable by fine not exceeding dollars, or imprisonment not exceeding days, or both, in the discretion of the county court, and the county courts are hereby given jurisdiction of all such offences.

SEC. 14. The words, "owner, lessee, or occupier," wherever used in this act, shall include corporations, companies, associations, or agents owning, holding, occupying, or responsible for the use or care of any lot or land within the limits of this State, and they shall be subject to all provisions of this act in the same manner and with like liabilities as any other owner, lessee, or other occupier of lands or lots, and service of notice upon any agent or officer of any such company, corporation, or association shall constitute service upon said company, corporation, or association.

SEC. 15. It shall be the duty of the road supervisor or other officer directly responsible for the care of public highways in each township or county in this State to destroy or cause to be destroyed all weeds mentioned in Schedule A on the highways within his district, at or before the times mentioned in said schedule, and in such manner as to effectually prevent the production of their seeds. He is hereby directed to warn out labor or to employ labor for this purpose in the same manner as for repairs to the highway, and for neglect or failure to perform this work he shall be subject to the same penalties as for the neglect or failure to perform duties pertaining to the repair of highways.

SEC. 16. The State Weed Commission shall prepare a plan for the eradication of weeds mentioned in Schedule A found growing on lands belonging to the State, and also on lands within the State, the title of which still remains in the Federal Government, and shall report the same to the Governor, to be by him transmitted to each branch of the Legislature during the first week of the next regular session of the Legislature.

SEC. 17. The State Botanist shall at least once in every two years visit each county in the State, and personally consult with the inspectors of said county in order that he may inform himself in reference to the status of the law as respects enforcement, and that he may intelligently and from personal knowledge bring before the commission at its next session the further needs of the State in such matters as are entrusted to said commission. His necessary expenses connected with such visitation, and with his attendance upon the biennial session of the commission, shall, upon presentation of a certified voucher, countersigned by the secretary of the commission, be paid by the State Treasurer in the same manner as are the other expenses of the commission.

The suggested bill seems to provide for all that is at present practicable, and if supported by a healthy public sentiment, will meet the necessities of the case. It has one feature that should commend it heartily, viz: its small demands upon the revenues of the State. It involves no expenditures on the part of the State except the necessary expenditures of the commission, which need not exceed a very few hundred dollars for each biennium. The expense of enforcing the law falls finally upon the negligent land owner or corporation, and no opportunity for annoying or expensive litigation seems to be opened up by this law.

OUR WEED LAWS AS AT PRESENT NOMINALLY IN FORCE.

For the information of those of our citizens who may receive this bulletin, a copy of our weed legislation as it now exists is given in full:

Be it enacted by the Legislature of the State of Wyoming:

SECTION 1. It shall be the duty of every person, company, association of persons, railway company, corporation and municipal or public corporation in this State to destroy or cause to be destroyed on all lands or premises owned, leased, occupied, controlled or used by such person, company, association or corporation, and upon all rights of way owned, used or occupied by either of them, the noxious weeds hereinafter mentioned, namely: the *Salsola kali* *tragus*, commonly known as the Russian Thistle and the Canadian Thistle.

SEC. 2. Each county road supervisor, district road supervisor, and board of the county commissioners in this State is charged with the duty of notifying the owner or occupant of any lands or premises upon which any of the noxious weeds mentioned in Section 1 of this act exist, of the existence thereof on such lands or premises, and the board of the county commissioners of any county may designate any county or district officers within their county, or any suitable person or persons therein, to give such notice, which shall be in such form, of such substance and purport as shall give effectual notice of the existence of the noxious weed or weeds to owner or occupant of the land or premises on which the same exists, and such board may allow such reasonable compensation, not exceeding three dollars per day for each day necessarily and actually employed by such officer or person so designated in the performance of such duty.

SEC. 3. Any person, company, association of persons or corporation mentioned in Section 1 of this act, who shall fail or refuse to destroy or cause to be destroyed any of the noxious weeds mentioned in this act on any lands or premises owned, used, leased, occupied or controlled by such persons, association of persons or corporation, including rights of way used, occupied or controlled by them, or either of them, after knowledge of the existence of any such noxious weeds on such lands or premises, shall be guilty of a misdemeanor, and, upon conviction thereof, shall be fined in any sum not to exceed five dollars for each day that any such noxious weeds shall remain living on the lands or premises owned, used, occupied, leased or controlled by such person, association of persons or corporation after the knowledge of the existence thereof or of notice of the existence thereof. The notice of the existence of any of such noxious weeds may be such as is required to be given by this act, or any notice, either oral or written, given by any person to the owner or occupant of lands or premises upon which such noxious weed or weeds exist, of the existence of the same.

Approved February 26, A. D. 1895.

SEVENTH ANNUAL REPORT

... OF THE ... 12666

AGRICULTURAL COLLEGE

... OF THE ...

UNIVERSITY OF WYOMING

... AND OF THE ...

WYOMING

AGRICULTURAL EXPERIMENT STATION

FOR THE FISCAL YEAR ENDING JUNE 30, 1897.

12666 32-33

LARAMIE, WYO.
THE REPUBLICAN BOOK AND JOB PRINT
1897

LETTER OF TRANSMITTAL.

To His Excellency

Hon. Wm. A. Richards,

Governor of Wyoming,

Cheyenne, Wyoming.

As President and Director I have the honor to present the Seventh Annual Report of the Agricultural College and the Agricultural Experiment Station of Wyoming. Owing to the change of the date for handing in the report, this report covers the work of the College and Station from July 1, 1896 to July 1, 1897.

Copies will be sent also to all Agricultural Colleges, to the Secretary of the Treasury, to the Secretary of the Interior, and to the Secretary of Agriculture, in accordance with Sections 3 of Acts of Congress of August 30, 1890, and March 2, 1887.

Respectfully Submitted,

A handwritten signature in cursive script, reading "Frank Pierpont Graves". The signature is written in dark ink and is positioned below the text "Respectfully Submitted,".

University of Wyoming,

June 30, 1897.

University of Wyoming.

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Instructor in Mechanical Engineering.

SEVENTH ANNUAL REPORT

. . . OF THE . . .

College of Agriculture of the University of Wyoming.

I hereby submit the report of the Agricultural College of Wyoming for the fiscal year of 1897 in compliance with the enactments of Congress.

Hitherto the report has been issued at the end of the calendar year, but for the convenience of the Director of Experiment Stations in reporting to Congress, the date of publication has been changed to June 30, the end of the fiscal year. This Seventh Annual report, therefore covers the last six months of 1896, for which a statement was also made in the Sixth Annual report.

ORIGIN OF THE COLLEGE.

The College of Agriculture and Mechanic Arts was simply an expansion into a distinct institution of departments which had existed in the University from the beginning. This was effected by an act of the Legislature of Wyoming, January 10, 1891, which vested the control of the appropriations from the Morrill and the Hatch Acts of Congress in the Board of Trustees of the State University.

This report is, therefore, the seventh concerned with the administration of these funds.

MANAGEMENT AND COURSE.

The Trustees of the College remain the same as the time of the last report with one exception, Col. Downey, president of the board from the establishment of the College of Agriculture, retired from trusteeship in February, and was

succeeded by Dr. Henry L. Stevens, a gentleman of broad scholarship and acquaintance with educational affairs.

The Faculty of the College has during the last six months been the same as that which appeared in the last report. Most of the scientific professors still occupy similar chairs in the College of Liberal Arts and thus the state is saved expense and a better corps of instructors maintained for both colleges.

The courses in agriculture and mechanic arts will be found at the end of the report for the College of Agriculture, and will be seen on examination to be equal in standard to the best institutions of the country. Both courses have been largely revised this year, to bring them nearer the model set by the Committee on Courses appointed by the American Association of Agricultural Colleges and Experiment Stations and by the best Agricultural Colleges of the United States. As the ideal of industrial education expands, the courses in this college will be revised from time to time, so that it may always stand in the forefront of agricultural institutions.

EQUIPMENT.

Very few additions have been made to the equipment of the College since the last report was issued, as the annual appropriations cannot be used until July 1. Large accessions have, however, been made to the various collections through the industry of the professors, and about one hundred books have been added to the library from last year's appropriation. A great increase in the facilities for each department is expected for next year.

METHODS.

The instruction of the agricultural course is given at the Main and Mechanical Buildings, and the practical instruction is carried on at the Farm of the Agricultural College and at the Experiment Station.

In the mechanical course instruction is given by means of text-books, lectures, reading in the library, practical problems, and a large amount of work in the drawing rooms, laboratories, shops, and in the field. Students are required to visit engineering works in the neighborhood and make reports upon them, inspections of construction and design receiving attention as well as details of correct work.

ATTENDANCE.

The attendance of the University has increased about fifty per cent during the past school year, and it is hoped that there will be an equal growth during the coming year. If conditions continue to improve in this state as much in the future as they have of late, the number of agricultural and mechanical students will be greatly increased.

NEEDS.

The College is still much in need of a scientific building to meet the demands of the large and constantly growing departments of physics, chemistry, geology, and biology. The instructors in these subjects are all earnest and progressive men, and this continued delay of proper facilities cannot but dampen their ardor. It is to be hoped that the state or some man of wealth who is interested in education will come before long to the relief of our overcrowded laboratories.

Report of Departments.

POLITICAL SCIENCE.

This department includes civics, public law, political economy, and sociology. Its aim has been to cultivate independent thought and foster intelligent citizenship. After the origin and growth of each subject has been investigated, and the general principles have been acquired, the student is required to apply the principles thus obtained to leading problems of the present day. Debates, public and private, form an important feature of the courses. The following subjects are offered:

I. *Constitutional Law.* Cooley; Black. Examination of cases; lectures; debates. [Elective for agricultural seniors.]

II. *International Law.* Walker; Gallaudet; Woolsey; Snow's Cases. Lectures; debates; theses. [Elective for agricultural seniors.]

III. *Political Economy.* Ely's Introduction; Walker; Marshal; Gregory. Lectures; debates; theses. [Required of agricultural and mechanical seniors.]

IV. *Comparative Government.* Wilson's The State; Wenzel's Comparative View of Government; Bagehot's English Constitution; Helie's Les Constitutions de France; Nicolson's Sketch of the German Constitution; Bryce's American Commonwealth. Lectures; theses. [Elective for seniors.]

SOCIAL SCIENCE.

The aim of this department is to familiarize students with the history of social development and to encourage investigation of the principles on which social progress depends. After a thorough grounding in the fundamental

facts, the student is expected to observe the social phenomena about him and to study the various problems in an independent manner. Inasmuch as sociology is a science of recent birth and its theories are constantly expanding, much of the class-work consists of lectures and theses. The following subjects are offered:

I. *Principles of Sociology.* Small and Vincent; Giddings; Kidd's Social Evolution. Lectures; debates; theses. [Elective for agricultural seniors.]

II. *Social Problems.* Study of crime, suicide, insanity, pauperism, charities, temperance, socialism, education, etc. Discussions; theses. [Elective for agricultural seniors who have taken I and Philosophy IV.]

III. *Social Philosophy.* Lectures on social theories, old and new, and on the aims of society. Discussions; theses. [Elective for agricultural seniors who have taken I and II.]

PHILOSOPHY.

The work of this department is intended to furnish an acquaintance with philosophic thought, to afford a training in the methods of investigating philosophic phenomena, and to imbue the student with the latest methods of education. Special attention is given to physiological psychology. The work in this subject is illustrated by charts and models of the brain and sense organs and by the introduction of various experiments. In teaching logic more time than formerly is given to inductive reasoning, as a perfect knowledge of this form is especially helpful to scientific students and to those intending to do research work in philosophy.

I. *Psychology.* James's Briefer Psychology, supplemented by outside reading and lectures. A consideration of the structure and functions of the nervous system and sense organs, of consciousness, attention, memory, emotions, movements, habits and their formation, and the

pathological conditions of the mind. [Required of agricultural juniors.]

II. *Physiological Psychology*. James. Ladd. Observation and experiments; investigation of special topics. [Elective for agricultural seniors.]

III. *Logic*. Jevons-Hill's Elements of Logic as text, with Fowler, Bain, Sidgwick, and others for reference. Treatment of the proposition, immediate and mediate inference, the hypothesis, arguments, and fallacies. Special attention to the principles and methods of induction. [Elective for agricultural seniors.]

IV. *Ethics*. Bowne's Principles of Ethics, supplemented by discussions and assigned readings from Spencer, Bain, Seth, and others. Examination of the principal theories and of special topics, such as the formation of the ethical ideal, the duties of the individual, of the family, and of society. [Elective for agricultural seniors.]

BIOLOGY.

The department of biology as at present organized includes botany, zoology, and physiology.

Even in the introductory courses laboratory work is made a prominent feature in order that from the first students may become self-reliant.

The equipment of the department has been adequate to the demands made upon it, and as new necessities arise in connection with the several courses, they will be supplied as far as possible from the resources at command.

One of the two rooms of the department is a convenient lecture-room having, among its other equipments, a lantern with microscope attachment. This enables the instructor to illustrate on the screen by both lantern and microscope slides the subject under discussion.

The laboratory is large and well lighted, and is furnished with working tables and desks. The following subjects are offered:

BOTANY.

I., II., III. *General.* The purpose of this introductory course is to give a general view of the entire field. The work progresses from the simplest plants to the more specialized forms. The first and second terms are devoted to the morphology and physiology of plants, and the third term to the ecology and classification of phanerogams. [Required of agricultural freshmen.]

IV., V. *Histology and Physiology.* A course in histology and experimental physiology of the higher plants, together with a consideration of some of the special problems of plant reproduction and morphology. [Elective for agricultural seniors.]

VI. *Mycology.* Fungi in general, but special attention is paid to those of economic importance. [Elective for agricultural seniors.]

ZOOLOGY.

I., II., III. *General.* The aim is to acquaint the student with the main facts of animal structure, physiology, and classification by means of lectures, laboratory work on typical animal forms, and prescribing reading. It is a prerequisite for the other courses in Zoology. [Required of agricultural sophomores.]

IV., V. *Comparative Anatomy of Vertebrates.* A study of the principal problems connected with the successive modifications of the different organs in the several classes of animals. [Elective for all who have taken I., II., and III.]

VI. *Microscopical Anatomy.* Microscopical technique, methods of investigation, and the preparation of sections of normal vertebrate tissues. [Elective for agricultural seniors.]

PHYSIOLOGY.

I. *Advanced Physiology.* This course assumes on the part of the student such general knowledge of the human body as is provided in the grammar grades of our best public schools. The course aims to review the more important subjects, to consider the problems of hygiene of special interest to all students. [Required of preparatory agricultural students.]

AGRICULTURE.

The instruction in agriculture aims to give the student the greatest possible knowledge of the science of agricultural practice in the time given. The larger part of the instruction is by lectures. Where text-books are used, they are supplemented by lectures, keeping the student abreast of the times.

Up to the senior year, as often as the other work will permit, students are required to work in the green-house or upon the agricultural grounds or experiment farm two hours each afternoon. As far as possible, the work is made to illustrate the branch being taught. The agricultural museum furnishes material with which to illustrate the study of farm crops and the agricultural productions of the world.

In the work upon the farm and the instruction in the class-room, the methods and results of the Experiment Station are always before the student. These will afford him much general information regarding the practice of agriculture in this region, and will give him an insight into the way by which important facts are deduced from the mass of daily observations and notes. The following subjects are required:

I. *History of Agriculture.* Taught by lectures and reference books, such as Goss' Principles of Plant Culture, and Johnson's How Plants Grow, and How Plants Feed. A

brief outline of the history of agriculture, followed by a thorough course in the principles of plant cultivation and growth. [Required of agricultural sophomores.]

II. *Soils, Tillage and Fertilizers.* Taught by lectures and reference books, such as King's *The Soil*, and Storer's *Agriculture*. [Required of agricultural sophomores.]

III. *Farm Crops.* Lectures. Planting, irrigating, harvesting, and marketing; laying out and improving farms; farm management and farm accounts. The students' practice will include setting up and running farm machinery, planting and irrigating crops properly. [Required of agricultural sophomores.]

IV., V. *Breeds of Live Stock.* Curtiss' *Breeds of Live Stock*, Warfield's *Cattle Breeding*, Miles' *Stock Breeding*, supplemented by lectures and practice in judging by scale of points. [Required of agricultural juniors.]

VI. *Stock Feeding and Dairy Management.* Armsley's *Cattle Feeding*, Henry's *Cattle Feeding*, and lectures. [Required of agricultural juniors.]

HORTICULTURE.

The instruction in this department aims to give the student a good general foundation in the science of gardening, plant cultivation, fruit raising, landscape and ornamental gardening. During the Spring term of one year, two hours of laboratory work each week in the multiplication of plants, grafting, budding and making cuttings are required. The following subjects are offered:

I. *Plant Forcing.* Study of green-houses and hot-beds, and of the cultivation and propagation of vegetables and small fruits. Lectures. [Required of agricultural juniors.]

II. *Pomology.* Pruning, grafting, budding, cuttings, and orcharding. Lectures. [Required of agricultural juniors.]

III. *Landscape and Ornamental Gardening.* Lectures. [Elective for agricultural seniors.]

IV. *Thesis Work.* Pollination, cross fertilization, variation, or other advanced subject. [Elective for agricultural seniors.]

ENTOMOLOGY.

This department aims to give the student an insight into insect life, and afford some knowledge of economic entomology through the study of injurious insects and the means for their extermination. The following subjects are required:

I. *Elementary.* Packard's Entomology, with Comstock for reference. Lectures. [Required of agricultural juniors.]

II. *Economic Entomology.* Smith's Economic Entomology, supplemented by lectures. [Required of agricultural juniors.]

IRRIGATION.

The object of this department is to give a general idea of the principles of irrigation practice and water measurement.

I. *Principles.* Effects of water on soil and crops, and measurement of water. Lectures, reference reading, and practical work. [Required of agricultural juniors.]

CHEMISTRY.

The work of all courses in the department of chemistry is experimental and inductive so far as consistent with the acquirement of the necessary amount of general information. Students are from the first encouraged to work independently on lines of investigation in which they are specially interested.

The department of chemistry occupies four rooms in the south end of the Main Building. One room contains the analytical balances and the chemical reference library, the second is devoted to the experimental work of the Wyoming Agricultural Experiment Station, the third is a lecture room, and the fourth and largest room is fitted up for the classes in qualitative and quantitative analysis. The department is well equipped with apparatus for research and analytical work in organic and inorganic chemistry. The following subjects are open:

I., II. *Elementary*. Freer, and Storer and Lindsay. The aim of this course is to give students a knowledge of the laws of chemical change, a practical familiarity with the principal elements and compounds, and skill in the manipulation of apparatus. [Required of agricultural and mechanical sophomores.]

III. *Qualitative Analysis*. Caldwell's Qualitative Analysis. Students will acquire the ability to detect the ordinary acids and bases in any substance. [Required of agricultural and mechanical sophomores.]

IV. *Quantitative Analysis*. Caldwell and Fresenius. Twenty simple gravimetric and volumetric determinations. [Elective for students who have taken III.]

VI. *Inorganic Preparations*. Erdman's Anleitung zur Darstellung chemischer Präparate. Preparation of a number of difficult compounds and elements. [Open to students who have taken III; spring term; laboratory work ten hours a week.]

VII. *Organic Chemistry*. Remsen's Organic Chemistry. Lectures and recitations on the compounds of carbon. [Required of agricultural juniors; fall term; five times a week.]

VIII. *Organic Preparations*. Text-book: Gatterman. Practical methods in organic chemistry. [Open to students who have taken VII; winter term; laboratory work ten hours a week.]

XI. *Agricultural Chemistry.* The chemistry of plant growth, and the application of chemical principles to practical agriculture with special reference to the problems of the arid region. [Required of agricultural juniors; winter term; lectures three hours and laboratory work four hours a week.]

XII. *Applied Chemistry.* Lectures on chemical processes and manufactures not included in metallurgy, and on methods of analysis and control. Most attention is paid to subjects of practical importance in Wyoming; such as petroleum and its products; coal, gas, and coke; building stone and cements; alkalies and acids; beet sugar; glass; air and water supply. [Required of mechanical juniors.]

The investigation of Wyoming petroleum has been continued by the professors of chemistry and geology. During the year three fields have been studied, the Popo Agie, Shoshone and Lander Oil Fields, and the results were published January, 1897, in a bulletin entitled, Petroleum Series, No. 2, The Petroleum of the Shoshone Anticlinal. Samples of oil from the northern part of the state will be collected this summer and a report made on the value of the petroleum of that district.

GEOLOGY.

Most of the instruction in this department is given by lectures, but text-books are used for reference together with the latest geological reports.

The location of the Agricultural College is exceptionally advantageous for the study of geology. Only a few miles east the Laramie mountains rise nearly 2,000 feet above the campus, while to the westward the Medicine Bow mountains rise 5,000 feet. Both of these mountain ranges are mineralized, and mining has been carried on for many years. They furnish rich fields for the student of structural

and dynamical geology, as well as for those who wish to study almost new archean exposures. Flanking these ranges are paleozoic, mesozoic, and cenozoic rocks that have been exposed by the mountain making and subsequent erosion, so that a student may easily make himself familiar with the entire series of Rocky Mountain sedimentary rocks. The working collections of rocks and fossils in the department are not large, but well selected and are increasing in size very rapidly. The collection of mesozoic invertebrates is very complete and the collection of jurassic vertebrates is the second in size in the United States. To those who wish to study economic geology special inducements can be offered, since ores of economic value are numerous, and are only a short distance away. The plains are also well supplied with mines of coal and deposits of clay, gypsum, and building stones.

The following list of books is used for reference and text work in this department: LeConte, Dana, Geikie, Kayser-Lake, Lapparent, Tarr, Zittel, and Nicholson and Lydeker. The following subjects are offered:

Dynamical and Structural. Geological forces, conditions in which stratified rocks are found, and general topography. Lectures; LeConte and Dana as texts. [Required of agricultural juniors.]

II. *Mineralogical.* Elementary study of mineralogy, in which a student is required to determine fifty species of common minerals with the blow-pipe. Lectures; Crosby and Brush as texts. [Required of agricultural juniors.]

III. *Historical.* Study of fossilized life associated with stratified rocks, and methods of determining formations from associated fossil life. Lectures; LeConte and Dana as texts. [Required of agricultural juniors.]

IV. *Economic.* Study of the minerals of economic importance and methods of preparing them for the market.

Lectures; Kemp and Tarr as texts. [Elective for agricultural seniors.]

V. *Paleontological*. Elementary course in paleontology. Lectures; Nicholson and Lydekker as text. [Elective for agricultural seniors.]

VI. *Advanced*. Course arranged to suit the needs of students. One week in the field. [Elective for agricultural seniors.]

HISTORY.

The purpose of the department of history is to create a taste for historical reading and give the ability to comprehend rightly the events of the times by applying the experience of the past to the conditions and problems of today. The aim is not the accumulation of a mass of facts and dates, but the acquisition of a right comprehension of great historical events.

Text-books are used, especially in the preparatory classes; but the study of the assigned lessons is supplemented by reading different authorities on the same subject and by lectures. The historical library has been greatly enlarged during the past year and is at the disposal of the students in this department. The following courses are offered:

I. *England*. Montgomery's English History. [Required of preparatory students.]

II., III. *Mediaeval and Modern*. Myer's Mediaeval and Modern History. [Required of preparatory students.].

IV. *Greece*. Smith's Shorter History of Greece. (Brownson's Revision); Guerber's Mythology. [Elective for agricultural seniors.]

V. *Rome*. Allen's History of Rome. [Elective for agricultural seniors.]

VI, VII, VIII. *Middle Ages*. Thatcher and Schwill

Lectures and supplementary reading. [Elective for agricultural seniors.]

ENGLISH.

The aim of the preparatory work in this department is to teach the student to understand and use the English language correctly, and to cultivate in him a taste for the best literature. A thorough mastery of English grammar is required before entrance to the Preparatory Year.

The student's work in literature is made to furnish the occasion as well as the material for the preparation of essays. These essays are subject to criticism both in the class and with the individual writers.

The formal study of rhetoric is designed to ground the student in the principles of English composition and to cultivate his literary sense by analytical study.

The work in oratory is of a practical character. An effort is made to secure reading that shall be intelligent, natural, and forcible, and to develop spontaneous expression from the mental side. The student meets the instructor personally for rehearsal and criticism.

The following subjects are open:

I, II, III. *Elementary.* Lockwood's Lessons in English. Selections from the following American authors are read: Longfellow, Irving, Hawthorne, Bryant, Holmes, Lowell, Whittier. Essays and recitations, based upon the text-book and reading. [Required of preparatory students.]

VII, VIII, IX. *Principles of Literature.* Careful reading of the following works: Milton's Paradise Lost, Books I and II; Pope's Iliad, Books I and XXII; The Sir Roger de Coverly Papers in the Spectator; Goldsmith's Vicar of Wakefield; Coleridge's Ancient Mariner; Southey's Life of Nelson; Carlyle's Essay on Burns; Lowell's Vision of Sir Launfal; Hawthorne's House of Seven Gables. [Required of mechanical sophomores and agricultural freshmen.]

X, XI, XII. *History of Literature.* History of English and American literature. Selected reading; composition; recitations. [Required of mechanical juniors.]

XIII, XIV, XV. *English Masterpieces.* Critical study of the masterpieces of English literature; especially, selections from Milton, Dryden, Pope, Thomson, Johnson, Gray, Goldsmith, Cowper, Burns, Coleridge, Byron, Keats, Shelley, Wordsworth, Macaulay, Matthew Arnold, Browning, Tennyson. [Required of agricultural sophomores.]

XIX, XX, XII. *Oratory.* Study of selections from great English and American orators. Principles of oratory exemplified in practice. [Required of seniors.]

MILITARY SCIENCE AND TACTICS.

The department of Military Science and Tactics is established in accordance with the requirements of an act of Congress donating public lands to colleges, one of the conditions being that military tactics shall be taught. It is under the control of an officer of the regular army, detailed by the war department for this duty, without any expense to the State, under the provisions of Section 1225, Revised Statutes of the United States. One hundred and fifty Springfield rifles (cadet pattern; similar to those used at West Point) and equipments, and cannon and sabers for artillery and cavalry practice, are loaned to the college by the U. S. Ordnance Department. An allowance of ammunition is annually supplied by the general government for purposes of target practice. All students are required to drill throughout the year. The cadet officers are appointed by the commandant of cadets, subject to the approval of the President. The commissioned officers are usually selected from the senior class, the sergeants from the junior class, and the corporals from the sophomore class, general merit and military efficiency being the qualifications considered.

Besides obtaining the excellent physical results which follow systematic and regular military training, the *morale* of the students will be thus improved. The virtues of patriotism, honor, and truthfulness are cultivated, and habits of neatness, promptness, and obedience are insisted upon.

The rules prescribed by the President of the United States for the government of officers of the army detailed as Professors of Military Science and Tactics require the following course of instruction:

1. The course of instruction shall be both practical and theoretical, and shall be so arranged as to occupy at least one hour per week for theoretical instruction, and at least two hours per week for practical instruction.

2. The practical course in infantry shall embrace small-arm target practice, and, as far as possible, all the movements prescribed by the drill regulations of the United States army applicable to a battalion. Instruction in artillery shall embrace, as far as practicable, such portions of the United States drill regulations as pertain to the formation of detachments, manual of the piece, mechanical maneuvers, aiming drill, saber exercise, and target practice. Instruction should also include the duty of sentinels, and where practicable, castrametation. Such instruction shall be given by the Professor of Military Science and Tactics personally, or under his immediate supervision.

3. Theoretical instruction shall be by recitations and lectures personally conducted and given by the Professor of Military Science and Tactics, and shall include, as far as practicable, a systematic and progressive course in the following subjects: The drill regulations of the United States army, the preparation of the usual reports and returns pertaining to a company, the organization and administration of the United States army, and the elementary principles governing in the art of war.

The military department shall be subject to inspection

under the authority of the President of the United States; such inspection shall be made, when practicable, near the close of the college year. The inspecting officer shall, upon his arrival at the institution, report to the President or other administrative officer in order to obtain from him the necessary facilities for the performance of his duty. A copy of the report of inspection will be furnished the President of the institution by the War Department.

Military drill has become a feature of all the courses in the University and it is required that all students appear at the drills in uniform. Students are advised to come to the college without especially providing themselves with new clothes and to arrange to wear the cadet uniform habitually while at college.

The cost of the uniform is about \$18.00. The grade of suiting, including the cap, wears well and proves to be economical.

All male students are expected to provide themselves with uniforms. It consists of a blouse, trousers, and cap, modeled after the West Point uniform, with raised gilt buttons.

COURSE OF THE SCHOOL OF MILITARY SCIENCE.

Practical.—Cadets are divided into two classes, First Year and Subsequent Year Cadets.

For all cadets: Practical instruction comprises the schools of the soldier, squad, and company in normal and extended order (Infantry Drill Regulations), guard mounting and guard duty, gallery and range target practice.

For Subsequent Year Cadets: In addition to the above comprises artillery drill, saber exercise, and military signaling with flag and heliograph.

Theoretical.—Cadets are divided into four classes. The winter term is specially devoted to this instruction, which includes the following:

First Year Cadets: Infantry Drill Regulations, including the schools of the soldier, squad, and company, in normal and extended order.

Second Year Cadets: School of the battalion and ceremonies (Infantry Drill Regulations), and U. S. Manual of Guard Duty.

Freshmen Class: "Elements of Military Science," Pettit.

Sophomore Class: U. S. Army Regulations, muster rolls and returns, etc., Military Law, and State Laws relating to the National Guard.

MATHEMATICS.

The instruction in mathematics aims to develop the powers of mental concentration, to give facility in attacking original problems, and ability to recognize the difference between logical proof and presumptive evidence, and to form in the student the habit of expressing his ideas in concise mathematical language.

All fundamental concepts are presented in as many different forms as possible, with fullness of explanation and variety of illustration, so that the student may thoroughly understand all the principles involved.

The following subjects are required:

I, II, III, IV. *Algebra.* Wentworth, Wells, Taylor, or Charles Smith. Fundamental operations. Fractions and fractional equations, simultaneous equations of the first degree. Problems involving two unknown numbers, simple indeterminate equations, involution and evolution. Radical and imaginary expressions, quadratic equations, ratio and proportion. [Required of preparatory students and freshmen.]

V, VI. *Plane Geometry.* Wells, Wentworth, Chauvenet, or Beman and Smith. Much of the time is devoted to

solving original propositions, and if time permits, some of the modern methods and the geometrical theory of proportion will be taught. [Required of freshmen.]

VII. *Advanced Algebra.* Wells' College Algebra. Progressions, binomial theorem, convergent and divergent series, undetermined coefficients, logarithms, permutations and combinations, summation of series, determinants, theory of equations, solution of higher equations. [Required of mechanical sophomores.]

IX. *Trigonometry.* Wells' New Trigonometry. The development of the general formulae and their application to the solution of triangles, polygons, and original field problems. [Required of agricultural juniors and mechanical sophomores.]

X. *Analytical Geometry.* Wentworth's Analytical Geometry. The analytical geometry of the straight line, circle, and conic sections; including a general discussion of the general equation of the second degree, and an introduction to the geometry of three dimensions. [Required of mechanical juniors, elective for agricultural seniors.]

XI, XII. *Calculus.* Osborne's Calculus. Differentiation of functions, successive differentiation, indeterminate forms, development of functions in series, maxima and minima, functions of two or more variable, tangents, normals, asymptotes, direction of curvature, singular points, curve tracing, evolutes, envelopes, and order of contact. Integration, application to geometry and mechanics, successive integration, integration of rational fractions, integration by rationalization, by parts and by series, lengths and areas of plane curves, areas of surfaces of revolution, and volumes of solids. [Required of mechanical and agricultural juniors, elective for agricultural seniors.]

PHYSICS.

The aims of this department are to cultivate in the student habits of thoughtful observation, intelligent and rapid manipulation, and to give him a general knowledge of natural phenomena. In all courses the subjects are studied from the experimental side, the student spending at least one-half of the time allotted to the work in the laboratory, under the direct supervision of the professor in charge.

The following subjects are offered:

I, II, III. *Elementary.* Carhart and Chute's Elements of Physics; Allen's Laboratory Physics. The properties of matter; mechanics of solids and liquids. Heat, sound and light. Magnetism and electricity. [Required of freshmen.]

IV, V, VI. *General.* Barker's Physics. Outlined experiments with reference to laboratory manuals. Physical quantities, kinematics, dynamics, work and energy, attraction and potential, and properties of matter. Energy of mass vibration, molecular kinetic energy, radiant energy. Energy of aether-stress, energy of aether-vortices, energy of aether-flow, and the electromagnetic character of radiation. [Required of mechanical juniors and elective for agricultural seniors.]

VII. *Electric Measurements.* Measurement of resistances, calibration of amperemeters and voltmeters, calculation of the electromotive force of batteries and dynamos, magnetic determinations, heating effect of currents, etc. [Elective for agricultural seniors.]

MECHANICS.

The aim of the instruction in this department is to give the student a thorough insight into the general principles governing prime movers and mechanical movements, and acquaintance with the methods in which these principles may be applied and combined in order to produce the desired ef-

fect in all branches of engineering. Instruction is also given in subjects which are rather more technical than theoretical, and the application of theory to practice is never lost sight of. The work is fully illustrated by frequent reference to the engineering and mechanical equipment of the university and other available sources.

The following subjects are required of mechanical students:

I. *Iron Working Machines.* Joshua Rose's Complete Practical Machinist. Study of the use and care of iron machinery, particularly the lathe; speed of different parts; screw cutting, turning excentrics, taps and dies; fitting connecting rods; pumps, etc. [Required of mechanical juniors.]

II. *Elements of Mechanism.* Stahl and Wood's Elementary Mechanism. Study of the elementary principles underlying mechanical movements and the modes of communicating motion. [Required of mechanical juniors.]

III. *Steam Boilers.* A Treatise on Steam Boilers, by Wilson and Flather. A general study of the different forms of modern steam boilers, their construction, advantages, and disadvantages. [Required of mechanical seniors.]

IV. *Steam Engines.* The Steam Engine, by Holmes. The mechanism and principles brought into use in the design of the modern steam engine. The two engines in the Mechanical Building are carefully studied in connection with the text book. [Required of mechanical seniors]

V. *Steam Engine Indicators.* The Slide Valve, by Rose, and Hemenway's Steam Engine Indicators. [Required of mechanical seniors.]

VI. *Engineering Materials.* Merriman's Mechanics of Materials. Theory of resistance of different materials, and study of those principally used in engineering, especially briks, stone, timber, iron and steel. [Required of mechanical seniors.]

VII. *Hydraulics.* A Treatise on Hydraulics, by Merri-

man. The flow of water through tubes, in pipes, canals, rivers, and over weirs; measurement of water power and pressure of flowing water. [Required of mechanical seniors]

VIII. *Thermodynamics of Gases.* A study of the properties of gases, saturated vapor, and superheated steam, and their application to the steam engine. [Required of mechanical seniors.]

DRAWING.

The aim of the department of drawing is to develop and quicken the ability of observation and to follow as closely as possible the line of work done in the practical drafting rooms of machine shops.

The following subjects are required:

I. *Freehand Drawing.* Drawing from models and copies, with which the department is well supplied. [Required of agricultural freshmen, and of mechanical preparatory students.]

II. *Freehand Lettering and Sketching.* Sketching parts of machines to be used in instrumental drawing. [Required of agricultural freshmen, and of mechanical preparatory students.]

III. *Use of Instruments.* A short course in straight and curved lines and lettering. [Required of agricultural freshmen and of mechanical preparatory students.]

IV. *Geometrical Constructions.* Geometrical problems used in instrumental drawing. [Required of mechanical freshmen.]

V. *Descriptive Geometry.* An elementary course in projection. [Required of mechanical freshmen.]

VI. *Projection of Shadows.* Isometrical and working drawings. [Required of mechanical freshmen.]

VII, VIII. *Instrumental Drawing.* Detailed copies of parts of machines. Drawing to scale of parts of machines

from sketches taken in the shop by the students. [Required of mechanical sophomores.]

IX. *Shades and Engineering Colors.* [Required of mechanical sophomores.]

X. *Machine Drawing.* Drawing and tinting machines and parts of machines. [Required of mechanical juniors.]

XI. *Parts of Machines.* Designing gears, cams, and parts of machines which apply to the study of Mechanics II. [Required of mechanical juniors.]

XII. *Tracing and Making Blue Prints.* Making working drawings to be used in the shops. [Required of mechanical juniors.]

XIII. *Machine Designing.* Designing a boiler or some simple machine; the design to be as original as possible. [Required of mechanical seniors.]

XIV. *Steam Engine Drawing.* This subject is to accompany the work in Mechanics V and VI. [Required of mechanical seniors.]

INDUSTRIALS.

This department is intended to simplify mechanical engineering by teaching practical work in connection with the theory. It aims also to present the practical side of production by running the machine shops as nearly as possible on the principle of actual manufacturing establishments.

I, II. *Wood Working.* Lectures on the care and management of carpenters' tools; exercises in lining, planing, sawing, notching, splicing, mortising, and tenoning. Bench work in wood; exercises in dovetailing, framing, paneling, and special work for the department. [Required of agricultural and mechanical preparatory students.]

III. *Wood Turning.* [Required of agricultural and mechanical preparatory students.]

IV. *Advanced Wood Turning.* [Required of mechanical freshmen].

V. *Circular and Scroll Sawing.* [Required of mechanical freshmen.]

VI. *Pattern Making.* Each class is required to make a complete set of patterns of some simple machine; these patterns are sent to a foundry from which castings are obtained to be used by the class in the machine room. [Required of mechanical freshmen.]

VII. *Iron Work.* Exercises in filing and chipping, and the use of the drill press. [Required of mechanical sophomores.]

VIII. *Iron Planing.* Exercises and special work. [Required of mechanical sophomores.]

IX. *The Engine Lathe.* An elementary course; tapering, screw cutting, etc. [Required of mechanical sophomores.]

X. *The Engine Lathe, Advanced.* Special work; turning up parts of machines, and work for the department. [Required of mechanical juniors.]

XI. *Milling.* Exercises; milling, sawing, gear, cutting, spiral cutting, and work on parts of machines. [Required of mechanical juniors.]

XII. *Engineering Laboratory.* Testing the efficiency of boilers, and inspection visits. [Required of mechanical juniors.]

XIII. *Engineering Laboratory.* Testing steam engines, learning the principles and operation of the steam engine indicator and rigging; inspection visits. [Required of mechanical seniors.]

XIV. *Shop Engineer.* General work in shop management, lining shaftings, and setting machines; inspection visits. [Required of mechanical seniors.]

XV. *Experimental Laboratory.* A thesis is produced in connection with the experimental work. [Required of mechanical seniors.]

THE LIBRARY.

The library, which is also the general reading room of the University, is situated on the second floor, in the north wing of the main building. This is a large, well lighted and ventilated apartment. The college students use this room during vacant hours from 8:30 a. m. to 12 a. m., and from 1 to 3:15 p. m.

The students at all times during the day, for five days in the week, have free access to all the books and periodicals. Three volumes may be taken by any one individual and kept from the shelves for a period of two weeks. Books reserved at the instance of professors as collateral reading for their courses are shelved in their respective rooms, and can be taken out only on application to such professors, who are responsible for them during the period of their reservation.

The library contains 4,679 bound volumes, and in addition several thousand unbound bulletins and reports on agricultural and scientific subjects.

There have been added to the University library, during the fiscal year 1896-97, 518 bound volumes and 600 pamphlets, including Experiment Station bulletins and publications from the Department of Agriculture at Washington, D. C.

The Board of Trustees of the University, at its annual meeting in June, 1896, made an appropriation of nine hundred and twenty-five dollars for reference books for the library. The scientific books as purchased, after being catalogued, are placed in the reference libraries in the respective laboratories in the University, the books for more general use being placed in the library proper. A pleasing increase of interest in the library has been shown by the students during the past year; the books are consulted with greater care, and the knowledge obtained has been particularly noticed in the departments of English and history.

The following agricultural papers and Wyoming newspapers are sent to the University:

Arkansas—	Massachusetts —
Farmer.	Farm and Home.
California—	Ploughman.
Press and Horticulturist.	Our Grange Home.
The Call.	American Cultivator.
West American Science.	New England Farmer.
Colorado—	Michigan—
Farmer.	Grange Visitor.
The Field and Farm.	Missouri—
Georgia—	National Dairyman.
The Southern Cultivator.	Nebraska—
Illinois—	Western Resources.
Prairie Farmer.	New Hampshire—
Orange Judd Farmer.	Mirror and Farmer.
Farmers' Review.	New Mexico—
The Farmer's Magazine.	Southwestern Farm and
The Elgin Dairy Report.	Orchard.
Irrigation Age.	New York—
Indiana—	American Agriculturist.
Clover Leaf.	Rural New Yorker.
Iowa—	Sugar Trade Journal.
Iowa Homestead.	Ohio—
Kansas—	American Grange Bulletin.
Farmer.	Pennsylvania—
Kentucky—	Germantown Telegraph.
The Industrial American.	Public Ledger, daily.
Louisiana—	Virginia—
Planter.	Southern Planter.
Maryland—	The Progressive South.
Farmer.	Washington—
Baltimore Weekly Sun.	Northwest Mining Review
Southern State.	

Wisconsin—**Hoard's Dairyman.****Ontario—****Farmers' Advocate.****State Papers—****Bill Barlow's Budget.****Black Diamond.****Boomerang.****Carbon County Journal.****Central Wyoming News.****Cheyenne Tribune.****Fremont County Gazette.****Green River Star.****Laramie Republican.****Laramie Times.****Newcastle News-Journal****News-Register.****Otto Courier.****Rock Springs Independent.****Rock Springs Miner.****Saratoga Lyre.****Saratoga Sun.****Sheridan Journal,****Sheridan Post.****Sun-Leader.****Wheatland World.****Wyoming Press.**

The scientific and general periodicals taken by the library and kept on the tables of the reading room are:

American Machinist.**American Naturalist.****American Gardening.****American Journal of Science.****American Geologist.****American Journal of Civics.****American Journal of Mathematics.****Agricultural Science.****Annals of American Academy of Political and Social Science.****Bulletins of the Torrey Botanical Club.****Botanical Gazette.****Book News.****Century.****Cosmopolitan.****Colliery Mining Magazine.****Education.****Educational Review.****Electrical World.****Engineer Magazine.****Erythea.****Etude.****Fliegende Blaetter.****Forum.****Garden and Forest.****Harper's Weekly.****Harper's Monthly.****Journal Society of Chemical Industry.****Journal of the Chemical Society.**

Literary Digest.	Popular Science Monthly.
Meehan's Magazine.	Psychological Review.
Microscope.	Philosophical Review.
Microscopical Journal.	Quarterly Journal of Pure
Mining and Scientific Press.	and Applied Mathematics
Monist.	Review of Reviews.
Nation.	Science.
Nature.	Scientific American and Sup-
North American Review.	plement.
Outlook.	Scribner.
Physical Review.	Western Electrician.

The University uses the Dewey Decimal Card Catalogue system, and in addition to the regular cards has those coming from the Department of Agriculture at Washington, containing a complete list of publications sent from that department and its several branches in connection with the Experiment Station work.

APPENDIX.



A. Courses of Study.

B. Treasurer's Report.

A. Courses of Study.

AGRICULTURAL COURSE.

For explanation of the Roman numeral, see departmental statements on preceding pages. The Arabic numerals indicate the number of hours a week. Where no numerals appear, 5 is understood. Two hours of laboratory, shop, or field work are counted as equivalent to one hour of recitation or lecture.

PREPARATORY YEAR.

FALL TERM.	WINTER TERM.	SPRING TERM.
History, I. English, I. Mathematics, I. Physiography, I. Industrials, I.	History, II. English, II. Mathematics, II. Physiography, II. Industrials, II.	History, III. English, III. Mathematics, III. Physiology, I. Industrials, III.

FRESHMAN YEAR.

Physics, I. Mathematics, IV. Drawing, I, 4. German, I. Botany, I, 4. English, VII, 1.	Physics, II. Mathematics, V. Drawing, II, 4. German, II. Botany, II, 4. English, VIII, 1.	Physics, III. Mathematics, VI. Drawing, III, 4. German, III. Botany, III, 4. English, IX, 1.
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SOPHOMORE YEAR.

Zoology, I. German, IV. Chemistry, I. English, XIII, 3. Agriculture, I, 2.	Zoology, II. German, V. Chemistry, II. English, XIV, 3. Agriculture, II, 2.	Zoology, III. German, VI. Chemistry, III. English, XV, 3. Agriculture, III, 2.
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JUNIOR YEAR.

Geology, I. Entomology, I, 3. Philosophy, I. Agriculture, IV, 2. Chemistry, VII.	Geology, II. Entomology, II, 3. Horticulture, I. Agriculture, V, 2. Chemistry, XI.	Geology, III. Horticulture, II, 3. Mathematics, IX. Agriculture, VI, 2. Meteorology, I, 2. Irrigation, I, 3.
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SENIOR YEAR.

Political Science, IV. English, XIX, 1. Elective, 10 hours.	English, XX, 1. Elective, 15 hours.	English, XXI, 1. Elective, 15 hours.
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MECHANICAL COURSE.

For explanation of the Roman numerals, see departmental statements on preceding pages. The Arabic numerals indicate number of hours a week. Where no numeral appears, 5 is understood. Two hours of laboratory, shop, or field work are counted as equivalent to one hour of recitation or lecture.

PREPARATORY YEAR.

FALL TERM.	WINTER TERM.	SPRING TERM.
History, I.	History, II.	History, III.
English, I.	English, II.	English, III.
Mathematics, I.	Mathematics, II.	Mathematics, III.
Drawing, I.	Drawing, II.	Drawing, III.
Industrials, I.	Industrials, II.	Industrials, III.

FRESHMAN YEAR.

Physics, I.	Physics, II.	Physics, III.
Mathematics, IV.	Mathematics, V.	Mathematics, VI.
Drawing, IV.	Drawing, V.	Drawing, VI.
French, I, or German, I.	French, II, or German, II.	French III, or Germ'n III
Industrials, IV.	Industrials, V.	Industrials, VI.

SOPHOMORE YEAR.

Drawing, VII.	Drawing, VIII.	Drawing, IX.
French, IV or German, IV.	French, V, or German, V.	French, VI, or German, VI
Chemistry, I.	Chemistry, II.	Chemistry, III.
Mathematics, VII.	Mathematics, VIII.	Mathematics, IX.
Industrials, VII.	Industrials, VIII.	Industrials, IX.
English, VII, 1.	English, VIII, 1.	English, IX, 1.

JUNIOR YEAR.

Mechanics, I.	Mechanics, II.	Mathematics, XII.
Mathematics, X.	Mathematics, XI.	Physics, VI.
Physics, IV.	Physics, V.	Drawing, XII.
Drawing, X.	Drawing, XI.	Industrials, XII.
Industrials, X.	Industrials, XI.	Chemistry, XII.
English, X, 1.	English, XI, 1.	English, XII, 1.

SENIOR YEAR.

Political Science, IV.		
Mechanics, III.	Mechanics, V.	Mechanics, VII.
Mechanics, IV.	Mechanics, VI.	Mechanics, VIII.
Drawing, XIII.	Drawing, XIV.	Thesis.
English, XIX, 1.	English, XX, 1.	English, XXI, 1.
Industrials, XIII.	Industrials, XIV.	Industrials, XV.

B. Treasurer's Report.

UNIVERSITY OF WYOMING,
Agricultural College,
Laramie, Wyo., June 30, 1897.

Report of Treasurer of said institution, to the Secretary of Agriculture and the Secretary of the Interior, of amount received under Act of Congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts, and of the disbursement thereof, to and including June 30, 1897.

Balance on hand July 1, 1896.....	\$ 6,480 33
Date of receipt of installment for 1896-97, July 8, 1896	22,000 00

Total available for year ending June 30, 1897	\$28,480 33
Disbursements thereof for and during the year ending June 30, 1897:	

Agriculture..	\$1,196 41
Mechanic Arts	3,619 24
English Language	2,024 25
Mathematical Science	874 94
Natural and Physical Sciences.....	9,288 43
Economic Science	4,461 80

Total expended during the year.....	21,463 07
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Balance remaining unexpended July 1, 1897.....	\$ 7,017 26
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I hereby certify that the above account is correct and true, and truly represents the detail of expenditures for the period and by the institution named, and that said expenditures were applied only to instruction in Agriculture, Mechanic Arts, the English language, and the various branches of Mathematical, Physical, Natural and Economic Science, with special reference to their applications in the industries of life, and to the facilities for such instruction

JOHN C. DAVIS,
Treasurer.

UNIVERSITY OF WYOMING,

LARAMIE, WYOMING.

REPORT OF THE PRESIDENT of said institution to the Secretary of Agriculture and the Secretary of the Interior, as required by act of Congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts.

I. CONDITION AND PROGRESS OF THE INSTITUTION FOR THE YEAR ENDED JUNE 30, 1897, ESPECIALLY—

1. Changes in course or methods of instruction. A preparatory year has been created for the Agricultural Course by adding another year at the end of the course and making the former freshman year preparatory. The courses in all departments have been carefully revised and the standards in most instances raised one year.

2. Purpose, structural character, and cost of new buildings or additions to buildings. A new wing of white sandstone is to be added to the Mechanical Building during the summer, to increase the facilities for forge and foundry work. The approximate cost is \$1,000. An addition will be made to the green house costing from \$300 to \$500.

II. RECEIPTS FOR AND DURING THE YEAR ENDED JUNE 30, 1897.

1. Balance on hand July 1, 1896, over and above all indebtedness (excluding funded debt, if any).....	\$ 4,032 53
2. State aid: (a) Income from endowment granted by state	
(b) Appropriation for current expenses.....	3,676 74
(c) Appropriations for building or for other special purposes.....	3,825 00
3. Federal aid: (a) Income from land grant, act of July 2, 1862.....	
(b) For experiment stations, act of March 2, 1887	15,000 00
(c) Additional endowment, act of August 30, 1890	22,000 00
4. Fees and all other sources (students and assaying, \$775.59; sales, \$595.82).....	1,371 41
Total.....	\$49,905 73

III. EXPENDITURES FOR AND DURING THE YEAR ENDED JUNE 30, 1897.

(Not necessarily a balance sheet as compared with Division II. above.)

1. Instruction in the subjects specified in Sec. 1, act of August 30, 1890*.....	\$21,463 07
2. Instruction in all other subjects, if any, not mentioned in Question 1 of this series.....	2,720 05
3. Administrative expenses (President's Secretary's, Treasurer's, Librarian's salary, clerical service, fuel, light, etc.)**	2,446 83
4. Experiment Station	15,595 82
Total	\$42,225 72

*The answer to this question will include not only the amount received under the act of August 30, 1890, ("Morrill Act") but also all amounts that are expended for the subjects specified in that act, irrespective of the character of the funds the amounts may be drawn from (State, tuition fees, or endowment, etc.)

**It may be convenient for many institutions to answer 2 and 3 as one question. Cost of new buildings is given under Division I.

IV. PROPERTY, YEAR ENDED JUNE 30, 1897.

Value of all buildings, \$100,000; of other equipment, \$40,000.

Value of above property (an estimate only is expected) not used for instruction in the subjects specified in Sec. 1 of act of August 30, 1890: Buildings, all used; of other equipment, \$15,000.

Total number of acres, 356; acres under cultivation, 180; acres used for experiments, 180; value of farm lands, \$9,540; amount of all endowment funds, none.

Number of bound volumes, June 30, 1897, 4,680; pamphlets, 3,000.

V. FACULTY DURING THE YEAR ENDED JUNE 30, 1897.

1. College of Agriculture and Mechanic Arts:

	Male.	Female.
(a) Preparatory classes.....	9	2
(b) Collegiate and special classes.....	9	2
(c) Total, counting none twice.....	9	2
2. Number in all other departments (excepting duplicates)	2	1
3. Number of staff of Experiment Station.....	6	1

VI. STUDENTS DURING THE YEAR ENDED JUNE 30, 1897.

1. Colleges of Agriculture and Mechanic Arts:

	Male.	Female.
(a) Preparatory classes.....	*3	*0
(b) Collegiate and special classes.....	23	0
(c) Post Graduate courses.....	0	0
Total, counting none twice.....	*26	0

2. Number in all other departments.....40 94

3. Number of students that pursued courses in agriculture, 2; mechanical engineering, 12; civil engineering, 1; electrical engineering, 0; mining engineering, 8; architecture, 0; household economy, 0; veterinary science, 0; military tactics, 57. (It is not expected that the sum of these figures will equal the number of students given above.)

4. What degrees and how many of each kind were conferred in 1896-'97?

On men, 11 (2 A. M.'s; 1 M. S.; 2 B. A.'s; 5 B. S.'s; 1 B. D. [Bach. of Didactics].)

On women, 4 (1 B. A.; 3 B. D.'s.)

5. What and how many honorary degrees were conferred in 1896-'97? None.

[Signed] FRANK PIERREPONT GRAVES,

President.

June 30, 1897.

*Besides the three students preparing for the mechanical course, there are 18 females and 14 males taking preparatory courses, any of whom may decide next year to take the agricultural or the mechanical course. How many will there is no way of knowing.

UNIVERSITY OF WYOMING.

Agricultural College.

SEVENTH ANNUAL REPORT

. . . OF THE . . .

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

For the Fiscal Year 1896-97.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

BOARD OF TRUSTEES.

Hon. OTTO GRAMM, President, Laramie.....	1908
GRACE RAYMOND HEBARD, Ph. D., Secretary, Cheyenne.....	1908
HENRY L. STEVENS, B. S., M. D., Laramie.....	1908
Hon. TIMOTHY F. BURKE, LL. B., Vice President, Cheyenne..	1901
Hon. JOHN C. DAVIS, Treasurer, Rawlins.....	1901
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Hon. MELVILLE C. BROWN, Laramie.....	1899
Prof. JAMES O. CHURCHILL, M. A., Cheyenne.....	1899
Hon. JAMES McAVOY, Lander.....	1899
State Supt. of Public Instruction ESTELLE REEL.....	Ex-Officio
President FRANK PIERREPONT GRAVES, Ph. P., LL. D.	Ex-Officio

AGRICULTURAL COMMITTEE OF THE BOARD OF TRUSTEES.

H. L. STEVENS, Chairman.....	Laramie
OTTO GRAMM	Laramie
M. C. BROWN.....	Laramie

PRESIDENT OF THE UNIVERSITY OF WYOMING.

FRANK PIERREPONT GRAVES, Ph. D., Litt. D., LL. D.

STATION COUNCIL.

F. P. GRAVES, Ph. D., LL. D.....	Director
B. C. BUFFUM, M. S., Vice Director, Agriculturist and Horticulturist	
A. NELSON, M. S., A. M.....	Botanist
E. E. SLOSSON, M. S.....	Chemist
W. C. KNIGHT, A. M.....	Geologist
C. B. RIDGAWAY, A. M.....	Physicist and Meteorologist
G. R. HEBARD, A. M., Ph. D.....	Secretary

SUPERINTENDENTS.

A. E. HOYT.....	Sundance Experiment Farm
M. R. JOHNSTON.....	Wheatland Experiment Farm
J. S. MEYER.....	Lander Experiment Farm
W. H. FAIRFIELD, B. S....	Wyoming University Experiment Farm
The Horticulturist in Charge,	

Wyoming University Experiment Grounds

SEVENTH ANNUAL REPORT

. . . OF THE . . .

WYOMING AGRICULTURAL EXPERIMENT STATION

FOR THE FISCAL YEAR 1896-97.

It is also my duty as Director to present to you the report for the Experiment Station for the fiscal year of 1896-97.

The published results of the Station are comprehended in five bulletins. The bulletins for July, September, and December, 1896, have already been issued in connection with the sixth annual report and will therefore be omitted here. The bulletins for March and June 1897 are appended. The title and outline of each bulletin is given below.

No. 29. Alkali, Some Observations and Experiments.

This is a thirty-six page bulletin, illustrated with plates. It takes up the composition of alkali in Wyoming, its effect upon soil and crops, and it reports some experiments showing the effects of such salts in the soil upon seed germination and plant growth.

No. 30. Stock Feeding Experiments at Lander.

This is a twelve page bulletin giving briefly the results in feeding steers, sheep, and lambs upon the Lander substation. It contains seven tables, giving the food eaten, the gains made, and the cost and profit with the different foods used.

No. 31. The Worst Weeds of Wyoming, and Suggested Weed Legislation.

This is a bulletin of fifty-eight pages, with fifteen illustrations of weeds. It contains descriptions of our most dangerous weeds and suggestions as to methods of exterminating them. A list of Wyoming's worst weeds is also given, and a form of law upon this subject is suggested to the Legislature of Wyoming.

Press Bulletin No. 5. Co-Operative Sugar Beet Tests.

This is a four page bulletin issued to the newspapers and farmers of the state, and gives directions for planting and cultivating sugar beet seed furnished by the Department of Agriculture.

No. 32. Potatoes.

This bulletin contains seventy pages including forty-five tables and gives the complete report of the experiments with potatoes on the six station farms during a period of three years. The points studied were the effect of using different fertilizers and of various methods of cultivation, methods of preparing seed, insect enemies and diseases, mode of irrigating, effect of altitude, cost and profit and comparative tests of fifty varieties.

No. 33. The Composition of Prepared Cereal Foods.

This bulletin contains sixteen pages and gives analyses of all the prepared oat, wheat and corn foods in the Cheyenne and Laramie markets together with a discussion of their relative value and the meaning of the analyses.

PLANS OF STATION WORK FOR 1897.

The following plans and instructions for Experiments have been partially carried out during this year. They were

recommended by the Station Council and approved by the Agricultural Committee of the Board of Trustees.

The Agriculturist.

Soil tests of 1896, continued.

Inauguration of additional soil tests.

Sub-soil experiments for 1896, continued.

Experiments with varieties of Wheat, Oats, and Barley, continued.

Grasses and forage plants. Additional varieties.

Potatoes.

Alkali experiments at Laramie and Sheridan.

Stooling test at Laramie, Lander and Sheridan.

Irrigation.

The Horticulturist.

Planting trees on campus.

Establishing a botanic garden on campus.

Floriculture for decorating campus.

Fruit experiments at Lander, continued.

Celery, on Laramie Farm.

New vegetables for trial.

Lander Experiment Farm.

Continuing fruit work.

Stockfeeding.

Stooling test, continued.

Sub-soil experiment, continued.

Sheridan Experiment Farm.

Stooling test, continued.

Alkali experiment, continued.

Small fruits, continued.

Irrigation.

Sub-soil experiment, continued.

Sugar beets.

Russian Sunflower.

The Botanist.

1. Further work upon the indigenous plants of the State, looking to a second report upon our flora, and, incidentally, the building up of the herbarium.
2. The collection of data upon the prevalence of injurious fungi, and the extent of injury caused by the same.
3. Further consideration of the weed problem.
4. The collection of further data upon the native small fruits and the preparation of a report upon the same.
5. A study of, and report upon, the native shade trees and ornamental shrubs.
6. The collection of data upon our forests, looking to a report upon forestry and the lumber interests.
7. The collection of data upon the poisonous plants of the State, especially the Locos, Larkspurs, Sneezeweeds, Poison Hemlock, and the Poison Laurels.
8. A study of and report upon the edible fungi of the State.

The Chemist.

1. Analysis of prepared cereal foods.
2. Determination of potential energy of foods with the calorimeter.
3. Analysis of alkali.
4. Study of the composition and circulation of underground water in irrigation.
5. Analysis of sugar beets.
6. Analysis of plants grown with and without irrigation and at different altitudes.

The Geologist.

Wind Erosion, continued.

Soil Formation, continued.

The relation of alkali to the stratified rocks, and its origin.

The artesian basins of Wyoming.

The geology of the marl deposits of Wyoming.

Collection of birds.

The Physicist.

1. Investigation of the physics of the soil.
2. Petrographic determination of the coarse admixed parts of the sand.
3. The behavior of soils toward water:
 - a. The power of retaining moisture in the soil;
 - b. The evaporating power of the soil;
 - c. The filtrating power of the soil;
 - d. The capillary action of the soil.
4. Cohesion and attraction of the soil.

The Meteorologist.

1. Continuation of the work of making observations and co-operating with the State and United States Weather Service.
2. Observations on the precipitation from as many places in the state as possible, especially at the higher altitudes.
3. Observations upon the direction and force of the air currents at Laramie.
4. Study of terrestrial radiation.
5. Amount of sunshine as compared with the total possible amount.

TREASURER'S REPORT.**WYOMING AGRICULTURAL EXPERIMENT STATION,****Laramie, Wyoming.****In Account With****THE UNITED STATES APPROPRIATION, 1896-7.****DR.**

To Receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1897, as per Act of Congress approved March 2, 1887..... **\$15,000 00**

CR.

By Salaries	\$6,414 96
Labor	3,476 81
Publications....	957 88
Postage and Stationery..	265 64
Freight and Express	146 74
Heat, Light and Water.....	904 06
Chemical Supplies	313 60
Seeds, Plants and Sundry Supplies.....	220 21
Fertilizers	54 85
Feeding Stuffs	128 01
Library	5 81
Tools, Implements and Machinery....	192 57
Furniture and Fixtures..	303 48
Scientific Apparatus....	172 15
Traveling Expenses	506 13
Contingent Expenses	43 75
Building and Repair	737 35
Balance	

\$15,000 00

We, the undersigned, duly appointed auditors of the Corporation, do hereby certify that we have examined the books accounts of the Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1897; that we have found the same well kept and classified as above, and the receipts for the year from the Treasury of the United States are shown to have been \$15,000.00, and the corre-

sponding disbursements \$15,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

[Signed] C. H. PARMELEE,
[Seal] J. A. McAVOY,

Auditors.

Attest:

GRACE RAYMOND HEBARD,
Custodian.

SUPPLEMENTARY STATEMENT.

DR.		
To Receipts from sale of Farm Products.....	\$595 82	\$595 82
CR.		
By Traveling Expenses.....	595 82	595 82
Balance.....	_____	

REPORT OF THE DIRECTOR.

The question of the abandonment of the sub-stations has caused considerable discussion this year. Under the directions of Circular No. 29, Department of Agriculture, Office of Experiment Stations, and in accordance with further recommendations from the department, this step has been rendered imperative.

The trustees of this Station have felt that the wide difference of altitude in Wyoming made necessary the maintenance of more than one regularly organized center for experiments and have for over a year remonstrated against the position taken by the Department. The trustees have, however, consented to establish coöperative tests after January 1, as suggested by the Director of Experiment Stations, in place of the sub-stations previously maintained.

This method of experimenting has proved to be very satisfactory in other states that have been obliged to abandon their sub-stations, and, it is hoped, will be successful here. The greatest difficulties here are the larger expenses for living and the few people who are willing to farm simply for the sake of experiment without much remuneration.

The Director has visited each of the farms twice and has been pleased with the work and interest of the Superintendents. It is recommended that these men be induced to act as coöperators after the formal work of the sub-stations has been closed. In most cases the superintendents have seen the Assistant Director of Experiment Stations, Washington, D. C., and are satisfied that the closing of their farms was a necessary step. They are now greatly assisting the Director in disposing of the farms and their equipment.

The improvement of the equipment at the Main Station, as recommended by the Department, is being carried out as thoroughly as our funds will permit. An enlargement of the farm house, together with a wing on the greenhouse have been added this year. An artesian well will be drilled and a horse-mower and other implements will also be purchased.

The station workers have been very active throughout the year. A larger number of investigations than ever, to be ultimately embodied in bulletins, are now under way. Each of these researches is mentioned and described under the report of the officers and need no further remark.

The Director and Vice Director have been appointed delegates to the convention of the Association of American Agricultural Colleges and Experiment Stations, to be held at Minneapolis in July.

REPORT OF THE AGRICULTURIST AND HORTICULTURIST.

The bulletins issued from this department during the fiscal year ending June 30, 1897, have been: "Alkali," in

July, 1896; "Stock Feeding Experiments at Lander," September, 1896; and "Potatoes," March, 1897.

Last season's work upon the Experiment Farm and at the sub-stations was carried out as planned and stated in the sixth annual report. The coöperative stooling test with grains which was in progress last season has been continued this year upon the Experiment Farm and the sub-stations at Lander and Sheridan. The three year potato test was finished last season as planned, report of which will be found in the Potato Bulletin. Some additional stock feeding experiments were carried out during the winter at Lander. The result of these experiments will be published later.

The horticultural work with large and small fruits has been especially successful upon the Lander Farm, and with small fruits upon the Sheridan Farm. The orchard trees upon the Wheatland Farm have suffered no serious calamity since they were planted, though a hail storm destroyed the fruit last season. We now have sufficient notes upon small fruits for a bulletin.

We have given more attention than in any previous year to grasses and forage plants and small grains. A large number of varieties of native grass seeds have been furnished by the Division of Agrostology of the Department of Agriculture, and are being grown. The scope of the work upon the Laramie farm is indicated in the report upon this farm by Mr. W. H. Fairfield. The Agricultural Committee of the Board of Trustees made Mr. Fairfield Superintendent of the Laramie farm in June, 1896. This enabled the Agriculturist to turn over to him many of the details of the farm work. He has also had direct charge of the daily records and crop notes, at the same time assisting in the general work of the department in a most efficient and faithful manner. The field notes taken this season will exceed by fully one-half those of last year. This year's crop report for the Laramie farm alone will cover over 260 pages of foolscap.

The records from the sub-farms are also quite extensive, and putting this mass of material into useful form by computing results and by collation, classification, and preparation for publication requires a large amount of routine work.

In connection with the United States Department of Agriculture we are carrying on a coöperative experiment with sugar beets this season. Seed was furnished about 140 farmers who requested it. Instruction in regard to the culture of the beets, and directions for sending samples were sent to each. This is an important line of work in this State, and we hope our farmers will become so familiar with the culture of the sugar beet under their conditions, that when the time comes for building factories, their success will be a foregone conclusion.

Out of the funds for this fiscal year \$500 were appropriated for permanent improvements on the Station. This has enabled us to build an addition to the green-house, and much needed buildings on the Experiment Farm.

The office of the Experiment Station was moved from room 32 in the basement to room 7 on the first floor, and the agricultural museum was moved from the same room to a room on the third floor. This gives a comfortable and roomy office near that of the President and Director. Putting the museum into another room is also of great advantage, as it will enable the Agriculturist and his assistant to do much of their indoor work with grains and other crops there.

In accordance with the suggestion of Director True, in addition to our regular soil records, the Station has organized a permanent line of soil experiments. The Agriculturist will attempt to test the lasting qualities of our soil with only ordinary cultivation and irrigation. Other soil investigations being made by this department are; the effects of rotation, planting of nitrogen gatherers, green manuring, fertilizing with manure, irrigation and cropping for alkali soil, sub-plowing and sub-irrigation.

The correspondence of the Station has steadily increased, showing a healthy growth in the interest taken by Wyoming farmers in the station work.

The Agriculturist has investigated some stock troubles in the State, and some bacteriological work has been carried on with Anthrax.

The crop experiments as planned are well under way this season.

REPORT OF THE BOTANIST.

The year ending June 30, 1897, has been a busy one. Investigation of problems in the field has occupied a considerable part of the time not taken up by routine work and classroom duties. In so large a field as this State and with the hindrances that field work usually suffers the investigations have not progressed so rapidly as it was hoped might be the case. The problems with which this department is now busying itself are found in the plans of work adopted by the Station for the year and so need not be repeated here.

The first two months of the year, viz., July and August, 1896, were devoted to field work on the flora of the State in order that our herbarium might have as complete a collection as possible.

The main purpose of the field work was to secure material of plants new to our collection, but incidentally a large amount of duplicate material was secured for exchange.

Three expeditions were carried out, viz: One covering five weeks, during which collections were made in Crook, Sheridan, Weston, Converse, and Laramie counties; one covering fifteen days in the mountains of southwestern Albany county; and one of a few days in northern Laramie county. The making of these collections necessitated nearly 1,600 miles of travel by rail, 184 by stage, and about 275 with

camp outfit, not counting the trips that were made at various times during the season in the vicinity of Laramie and in the Laramie Hills.

Altogether, during the season, there were collected in duplicate (approximately ten sheets of each) about 950 numbers or between 9,000 and 10,000 sheets of plants. Only about one-half of this material has been worked as yet, but enough has been done to show that a large number of species has been added to the collection both of seed and spore producing plants. Some of these, it seems probable, will prove new to science.

Visits were made in July and August to the Sundance, the Sheridan, the Wheatland, and the Laramie Experiment Farms. Special observations were made at each of these places in regard to the prevalence of fungus diseases of the several crops. It is my pleasure to report again that so far, at least, we are remarkably immune from all fungi except those forms which vegetate in the tissues of the host during the entire period of the host's development; as, for example, the smuts.

Data are being collected upon the native fungi, and among those observed may be mentioned the Black Knot of Plum and Cherry. This was found in abundance on the native species in Sheridan county, near Parkman. Thus far no injury from this disease has been reported from any part of the State.

For several years data upon the weeds of the State have been sought. Particularly during the past season have such facts concerning the prevalence of noxious weeds come to hand from personal observation as to demand a bulletin upon this subject. Said bulletin has just been published as No. 31. For list of weeds described and illustrated, reference is made to the bulletin as incorporated in the Annual Report.

As fast as may be, data are being secured upon the ornamental trees and shrubs of the State; the native small fruits; and upon the forests and forest conditions in Wyoming. The collection of data upon and specimens representing our flora will, of course, continue with a view of making our collection as complete as possible.

The correspondence of the department is constantly increasing, letters on various botanical subjects such as weeds and the determination of other points being frequently received. These all receive prompt attention and the best information at hand on the subject of the inquiry.

REPORT OF THE CHEMIST.

A report on the composition of all the prepared cereal foods in the Laramie and Cheyenne markets was published in June, 1897, as Bulletin No. 33. No evidence of adulteration or of inferior quality was found in any of the samples but there is such a wide variation in character and price as to show that these breakfast foods should not be used indiscriminately as they are at present.

The work of analyzing the alkali of the State is being continued and a bulletin will probably be published on the subject during the year.

Packages of sugar beet seed have been distributed to a hundred and fifty farmers of the State and samples of the beets sent to this Station will be analyzed.

REPORT OF THE GEOLOGIST.

Work has been continued along three lines of investigation during the year, but sufficient data has not been secured in the form of a bulletin.

During the past season the following subjects have been studied:

Wind Erosion.

Soil formation and Geological Study of Rocks entering into soil.

Artesian Basins in the State.

Since there is much valuable land in Wyoming that is not watered by nature, and there are no streams from which to irrigate, it has been thought best to make a careful survey of the State to determine the location of artesian basins so that the Station may recommend the drilling of wells in such places in order to furnish water for irrigation.

This work has been carried on in the following localities: The east end of Freezeout Hills in Carbon county; along the south slope of the Seminoe Mountains; in Laramie county, along the foot of the Laramie Mountains, extending from the Big Laramie river to the west line of the county; in Sweetwater county, from six miles north of Green River to twenty miles below; in Fremont county, along the foot of the Wind River Mountains, and from Hailey northwest to Fort Washakie.

This work is now about one-half completed, and will be finished as soon as possible.

An extensive deposit of phosphatic marl in this country has been thoroughly studied and samples taken for analysis.

REPORT OF THE PHYSICIST.

The present physicist was appointed June 12, 1896. He entered upon his duties July 1st, and immediately began preparation for the physical analysis of the thirty soil samples which had been collected by the Agriculturist during the previous year. The work is now about completed, and a bulletin will soon be published giving the results of the in-

vestigation together with the determination of the quantity of moisture in the soil in the field during the growing season.

The following are some of the physical properties of the soil which are being examined as rapidly as circumstances will permit:

1. State of division.
2. Behavior of soil towards moisture.
3. Relation to heat.
4. Capillary power.
5. Cohesion and adhesion of the soil.
6. Absorbent power of soils for gases.

REPORT OF THE METEOROLOGIST.

The meteorological observations made during the past year have been similar to those of previous years. The equipment of the station consists of a complete set of instruments for obtaining the relative humidity, maximum and minimum temperatures, pressure of the air, rainfall, snowfall, velocity and direction of the wind, evaporation, percentage of sunshine, and temperature of the soil at various depths. The velocity and direction of the wind is recorded by a self-registering apparatus, operated by an electric battery. All observations, excepting those which are self-registering, are taken at 7 a. m. and 7 p. m.

In addition to the observations made at Laramie, the maximum and minimum temperatures, precipitation of rain and snow, and the percentage of sunshine, have been recorded at most of the Experiment Farms, while many voluntary observers throughout the state have rendered valuable assistance in making monthly reports of the amount of precipitation and the temperatures of their respective localities.

The next bulletin to be issued from the Meteorological

Department will be on the amount of sunshine as compared with the total possible amount.

REPORT FOR THE LARAMIE EXPERIMENT FARM.

The general plans for last season's work were fully carried out.

The season proved to be an average one, and our results were very satisfactory.

The three years' test with potatoes was concluded. Work with various forage crops was continued and their growth and habits carefully observed. The amount of water used in irrigating the different crops was measured as accurately as possible. Work in sub-irrigation was continued. The test of the stooling power of grain planted at different distances apart has furnished some interesting data.

The new lines of investigation begun this season, which are to continue year after year, have been carried on successfully. In commencing the special study and work on the varieties of cereals best adapted to our conditions, seed of 613 varieties were obtained. Out of this number, 506 matured seed and were harvested. Notes were kept for each individually.

In the sub-soil tests, wheat, barley, oats, turnips, beets, and potatoes were tried with varying results.

An acre plat was set aside for the permanent soil tests, one half being seeded with wheat, the other half with oats.

The usual amount of work was accomplished with general farm and garden crops. The total number of varieties planted and the different treatments given, with the different conditions under which the same varieties were planted, reached one thousands, requiring this number of entries in the crop report. Of this number, 804 matured and were harvested.

Some much needed permanent improvements were made on the farm, consisting of a shed for the shelter of tools, and a small root cellar. Some necessary machinery was procured from the abandoned experiment farm at Saratoga, including a mowing machine, horse rake, potato digger, and plows, cultivators, etc. A light buggy and a one-horse thresher and tread-power were purchased.

The present season a team and some other equipment were obtained from the Wheatland farm. The work as planned and given in the Director's report for this season is well under way.

REPORT OF THE LANDER FARM.

Small grains are doing well. The yields last season were rather above the average of former years. Forage crops were very successful, especially alfalfa. The new ground, about eighteen acres, and five of the old acre plats, that were seeded to alfalfa last spring, have made a fine growth, and as there is a good stand, will undoubtedly make a good yield this season.

Half an acre each of orchard grass, red clover, rye grass, and sanfoin were sown, made a good growth, and have a fairly good stand.

The new forage plant, Australian salt bush, which was recommended so highly for alkali lands, has done best where the soil is not so strong with alkali, though the roots may spread another year and cover the ground where it is crusted with alkali. It made a growth of twelve inches last year from the seed.

The flat pea (*Lathyrus sylvestris*) was transplanted last spring and made a good growth, but the vines kept to the ground so close that it could not be mown to any advantage.

As I understand this plant is not expected to be of any

value until the third year, we can expect no record of its hay value this year.

The farm now has some 26 acres seeded to grasses, mostly alfalfa, with a mixture of timothy. Amount of seed used per acre last season, alfalfa, 18 pounds; timothy, 3 pounds.

The small grain stooling experiment was successful, both as to stools and yields.

On the sub-soil plat, crops yielded best on the half not sub-soiled.

All root crops did well, and the twenty new varieties of potatoes, one pound each, sent us from the Laramie farm last season, nearly all made good records.

Garden vegetables, with a few exceptions, did well.

The effect of the freeze of September, 1895, is very apparent in the orchard, fully 75 per cent of the trees having been killed. This is not altogether a total loss, as a large number have started growth above the graft, and in a few years will be as good as when injured. A few apples of the following varieties matured: Wealthy, Yellow Transparent, and Tetofsky.

The canes and vines of the small fruits, including grapes, made an excellent growth, but owing to the freeze of September, 1895, the old canes fruited very little—not enough for record. A few nice bunches of the following varieties of grapes ripened: Concord, Wyoming Red, and Delaware.

The nursery stock set out in the spring of 1895 suffered severely in the September freeze of that year, nearly all of it killing down to the snow. As this covered the graft, there is no material loss beyond that of one year's growth. The last season's growth was stronger and thriftier than the preceding season's.

Of the live stock, the sheep purchased for the farm did well, each of the ewes having a fine lamb.

The trio of blooded berkshire hogs bought in the spring have made no increase as yet, but have thrived and are in fine condition.

It has been suggested by some of our citizens that from now on the Lander farm could better serve their interests by continuing the horticultural work and stock feeding experiments.

As will be seen by Bulletin No. 30, we made a fairly successful experiment in the winter of 1895-96 in marketing our crop by feeding it to stock, and there is no doubt that further experiments will fully demonstrate that the most profitable way for our citizens to market their crops will be in feeding them to stock.

The sales on the farm are small, as the crops are now used for farm stock.

REPORT OF THE SHERIDAN FARM.

The weather was hot and dry during July and August of last season, with a scarcity of irrigation water, but by irrigating those crops first which would ripen first, none were allowed to burn or become injured to any great extent. Grains planted on sod ground suffered the most. The first killing frosts in the fall did not occur until September 19 and 25. This allowed peanuts, melons, tomatoes, and other vegetables to fully mature.

The plans for the year have been fully carried out. The potato test did not give as good results as heretofore, and the crop was a poor one. The potatoes in this county which were planted early and watered when both the ground and the water were very warm, seemed to blight badly. The Australian salt bush has succeeded finely upon our worst alkali ground. The plants have nearly covered the ground

even where no weeds would grow, and should it live through the winter it may prove of value for such land. Flat pea has made good crops, but as yet I have failed to find any animal which will either graze on it or eat the cured hay. The experiments upon the stooling power of grains and upon subsoiling have both been carried out successfully. Three additional acre plats were laid out, broken, and planted to grain.

Improvements made upon the farm were some bridges over ditches, plastering the new cellar both inside and out, and the construction of additional drains through the alkali ground. One hundred rods of new drain ditch were made, twenty rods of the old ditch deepened, and a ditch opened across the south end of plats 1 to 4 to catch waste water which runs from the adjoining farm.

The rains of August, 1895, raised the sap in our trees and the severe freeze following in September killed our orchard of apples, plums, and cherries. The nursery stock was killed down to the ground, but much of it came up again from above the graft and has made fine growth this season. One-fourth of an acre was set to raspberries, blackberries, and gooseberries, and one-half acre to strawberries. Five of our strawberry growers wish this farm to test the length of time a strawberry bed will produce a paying crop. For this purpose I have left twenty-two rows of the old bed, plowing up the rest after the new bed was set. All our small fruits and nursery stock were well wooded and went into the winter in the best possible condition.

The land of the Sheridan farm is in better condition than at any former time. The dry season, together with our drain ditches, has prevented alkali deposit, and the ground is in a better state of tilth. This season a hail storm destroyed a large per cent of the strawberries and other small fruits. The stooling test grains are looking well and other experiments as planned are well under way.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

PRESS BULLETIN NO. 5.

APRIL, 1897.

Co-Operative Sugar Beet Tests.

- I. Sugar Beet Seed Furnished Free.
 - II. Instructions for Cultivating Sugar Beets.
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[The press of the state is requested to publish the first part of this bulletin asking farmers to co-operate with the Experiment Station, and is invited to print all of it.]

I.

Sugar Beet Seed Furnished Free.

The Office of Experiment Stations of the United States Department of Agriculture has furnished the Wyoming Experiment Station a quantity of sugar beet seed to be distributed to the farmers of the state for co-operative tests. The results of experiments with this seed are to be sent to the chemist of the Wyoming Station at Laramie along with samples of the beets for analysis. All the data collected will be forwarded to the United States Department of Agriculture for publication, and if enough samples are obtained, the results will also be published in this state.

The investigation of the Wyoming Experiment Station in 1891 and 1892, established beyond a doubt the adaptability of many of our soils to this important crop. It is hoped and expected that the co-operation of our farmers this season will advance the interests of the state by calling attention to our superior conditions of soil and climate for the production of sugar beets.

Sugar factories are being established in other states and early recognition of the superior inducements which can be offered in Wyoming is of the greatest importance. Farmers co-operating with the Station will be to no expense, unless it be a few cents postage on beet samples sent in for analysis. The seed will be furnished free and the crop raised is a valuable one both for the table and as a stock feed, in both cases being preferred to red beets. In France seventy-five per cent of the sugar beets raised are for stock feed instead of the production of sugar. By growing them every year for stock food, our farmers are paving the way for the establishment of factories, since thus what can be done is determined, experience is gained in the production of beets, and knowledge is acquired which will give confidence in the crop when the time comes for the manufacture of sugar.

THOSE WISHING SEED SHOULD SEND IN THEIR NAMES AT ONCE, as the supply is limited, and those applying will be supplied in order of their application so long as the seed lasts. One pound of seed will be sent each applicant by mail under the United States congressional frank. This will be sufficient to plant one-sixteenth of an acre. Full cultural directions, with instructions for sending samples and blanks for reporting, will accompany each pound of seed.

II.

Method of Cultivation.

SOIL:—Take the best soil on the farm. A sandy loam is best, but do not use land so sandy that it shifts with the wind or dries out too much. The soil should be deep and with good drainage. If it has a dressing of stable manure, so much the better, especially if it was applied to a crop last year. If applied this year, do not put on too much. Land plowed last fall is preferable. The earlier and deeper it is plowed the better. It should be plowed long enough to make a well pulverized, mellow seed-bed, and to kill all young weeds.

PLANTING:—The seed should be planted in May; from the 10th to the 20th is recommended, if the soil is in the right condition to work. If the soil is very dry or likely to become so, it is well to leave a shallow furrow between each row of seed, so that the plants may be irrigated up, but this should not be resorted to unless absolutely necessary. If obliged to irrigate to bring the seed up, do not allow the soil to dry out and form a crust. Cultivate the surface as soon as the plants are up enough to show the rows distinctly. Plant the seed in rows from fifteen to twenty inches apart and from one to three inches deep. A hand seed drill is best. After planting, the rows should be tramped upon to firm the soil around the seed. If planted by hand; drop the seed in shallow furrows, cover with a hand plow or hoe, and tramp the soil, to firm it around the seed.

CULTIVATION:—This should begin as early as possible and should occur often enough to keep down all weeds and keep the ground mellow. Beets require thorough cultivation. After trimming, during June and July the cultivation should reach a depth of six inches. Cultivate shallow as soon after irrigating as the ground can be worked, and cultivate deep before the next irrigation. Care should be taken not to break the leaves or to throw the soil against the plants, hilling them up, as they need flat cultivation to give them all the air and sunshine they can get.

THINNING:—When the beets have developed four leaves, they should be thinned. This is best done by first going through the rows with a hoe, cutting out from four to six inches of beets, and leaving bunches between that contain a number of plants. After bunching in this way, thin by pulling out all but the largest and healthiest beet in each bunch.

IRRIGATION:—Beets require considerable water during the growing period in June, July and August. They should not be kept so wet that the ground becomes sour or soggy, or contains so much water that it cannot be kept in a good state of tilth and well aerated by cultivation. Nor should the soil be allowed to get so dry that all the leaves wilt. Irrigate in furrows made between the rows in such a way that the water will not flood over or around the crowns of the beets. Cultivate as soon after each irrigation as the ground gets dry enough to work. Run the cultivator shallow, to break up the surface crust.

DO NOT IRRIGATE UNTIL THE BEETS SHOW UNMISTAKABLE SIGNS OF NEEDING MOISTURE, as irrigating too soon or too often is apt to spoil both the shape and quality. When the bottom leaves begin to wilt and the top ones to turn a dark green, they need water. If the tops have a light greenish yellow appearance, they have been kept too wet. They probably will need from three to five irrigations. The number of times necessary will depend upon the supply of moisture. They should not be irrigated later than the last of August, as the beets require dry, sunny weather during September, to ripen and store up a large per cent of sugar in the juice.

HARVESTING:—The beets should be mature about the first of October. Ripening is indicated by the outer leaves turning yellow and dying. They should be harvested in October before hard freezing weather. If a hard freeze occurs they should not be taken from the ground until thawed out as in this way the frost will leave the beets gradually without destroying them. Loosening the soil between the rows with a narrow plow will enable the beets to be pulled without bruising them. Cut off the tops squarely together with a little of the rough portion of the beets. The best size is from one to three pounds. If they weigh over four pounds, they are apt to be poor in sugar. Beets may be stored in root cellars or pits in the ground, like potatoes or other root crops. They keep better if covered with soil which comes in contact with the beets, as this prevents wilting. If stored in pits for any length of time, they should be covered with five or six inches of soil, then a layer of straw of the same thickness, and more soil over the straw as the weather gets very cold. Where placed in pits or silos, a hole must be left in the top for ventilation, filling it with straw or sacks instead of with soil, as cold weather comes on.

Directions for taking samples for analysis will be printed on report blanks furnished with the seed.

B. C. BUFFUM,
Agriculturist and Horticulturist.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,
LARAMIE, WYOMING,

BULLETIN NO. 32.

MARCH, 1897.

POTATOES.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

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ACKNOWLEDGEMENTS.

Much of the information contained in this bulletin has been obtained from the reports and observations supplied by the superintendents of the several experiment farms, (see names on inside cover) who have carried out the experiments as planned by us. W. H. Fairfield has ably assisted in the work, having made the greater part of the computations and tables.

I am grateful to the above station workers, the members of the station staff and others who have kindly aided in the preparation of the bulletin and in reading proof. Mr. Herbert Myrick of the American Agriculturist kindly furnished the article on pages 38 to 41. He sent additional information in regard to the prize contest, which I regret to say, came to late for insertion.

B. C. BUFFUM.

POTATOES.

B. C. BUFFUM.

Potatoes succeed in all parts of Wyoming, and form one of our most important and valuable farm crops. They seem capable of adapting themselves to all our conditions of soil, climate and altitude. Good yields are obtained in sheltered places up to 9,000 feet above the sea, even where light frosts are frequent during the growing season. The phenomenon of sufficient cold to produce a fringe of ice along a stream and still leave uninjured as tender foliage as that of potatoes, has often been observed, but so far as I am aware has not been explained. It would seem that the radiation is sufficient to cool the already cold water below the freezing point, while foliage on higher ground is protected by warm layers of air and the heat absorbed during the day. At altitudes above 7,000 feet potatoes will ordinarily produce fair crops without irrigation. Below 7,000 feet altitude it is generally not safe to plant any crop where it can not be irrigated, but where they have been properly cared for and watered we have never recorded the failure of a crop, excepting small local failures where the cause is generally apparent.

The importance of the potato crop and the fact that so little was known of its possibilities, especially in the southern part of the state, led the station officers to inaugurate special experiments with potatoes on each of the farms. The same varieties have been grown upon each of the farms, and varied experiments have been made. Growing them under different soil conditions and at different altitudes, green manuring, different amounts of seed per acre, and dif-

ferent methods of preparing and treating the seed and crop have been investigated, reports of which are given in the following pages. Results with potatoes are so variable that it is impossible to draw a conclusion which applies to every year and all conditions. In order to make our results as nearly average as possible and eliminate the more apparent sources of error, a comparatively large number of varieties were grown in connection with the soil work and green-manuring tests of the home station. Here fifty varieties were grown under each of the conditions of 1895 and 1896, and we believe the average of so many in each case gives more reliable data than where a single variety is grown. In those parts of the state where agriculture is new there is a demand for information with regard to the best varieties. On this account a variety test was inaugurated. As such a test for a single season gives no reliable results the varieties under consideration were to be grown three seasons before a report should be made. No attempt has been made to grow all the varieties of potatoes that could be obtained. Fifty standard sorts were chosen, and in part two of this bulletin is given a report of this three years' test at each of the stations. We believe the varieties which have succeeded best with us during the past three years will succeed better than those which gave the poorer yields, if good, reliable seed is obtained.

Soil Work With Potatoes.

FOLLOWING DIFFERENT CROPS, LARAMIE, 1895:
—Table I gives the yield, average per cent marketable, and average weights of the twelve largest tubers of fifty varieties on four kinds of soil. The millet stubble was land sown to millet in 1894, the crop of millet was harvested August 27th, and yielded at the rate of three tons and thirty pounds of cured hay per acre, and 731.6 pounds of seed. The timothy and clover, fall-plowed, was practically fallow land in 1894. Both timothy and clover produced poor stands, and the ground was plowed the middle of August to kill the weeds. The wheat yielded 36½ bushels in 1894. The potatoes on the millet land made the largest yield. All the land was treated alike so far as possible, only differing in the kind of previous crop, the time the previous crop occupied the land, and in the irrigation of these crops, except that the timothy and clover land was fall plowed. The millet only received a partial irrigation early in the season of 1894. The timothy, clover, and wheat were each irrigated three times, the last irrigation occurring July 17th. When the potatoes were planted all the ground was very dry and they were irrigated to bring them up. After this irrigation a long period of cold wet weather greatly retarded their growing. Under these circumstances the lack of water on the millet land in 1894 may have influenced the yield of potatoes in 1895. The differences between those on the timothy and red clover land are not so easily accounted for. There is no apparent reason for the yields on the clover land falling below the average yield for each variety on all the land planted. A comparison of these with the yields from wheat land would indicate that fallow land, fall-plowed, will produce much larger

yields of potatoes than land which has produced a large crop of wheat. One per cent of the potatoes on the millet ground was affected with scab, one-half of one per cent on the timothy land, and on the other ground a trace only of scab was present.

TABLE I.—*Potatoes on Different Soils, Laramie, 1895.*

FIFTY VARIETIES.	Millet stubble	Timothy, Fall plowed	Red Clover, Fall plowed	Wheat stubble	Total on the four divisions
Average yield, pounds	9899	9598	7082	5995	8606
Average per cent marketable	84.6	85.0	83.0	74.8	83.6
Average weight of largest twelve, in pounds.....	4.6	4.8	4.2	5.6	5.6

POTATOES ON DIFFERENT SOILS, LANDER, 1893:

—Eight varieties were grown on each of the two kinds of soil represented on the experiment farm. The soil and crops on the two plats were treated alike. Plat No. 1 is first bench land above the river. It is a deep red colluvial soil, containing little humus. Plat No. 2 was on the bottom next to the river, and differs from No. 1 in that it is a black soil, containing a large amount of vegetable mold.* The large differences in yields in the third column of the table show the effects of different soils in the same locality on a crop and the importance of selecting that most suitable to the crop to be grown. The average increase in yield of the eight varieties on Plat 2 amounts to 105 per cent.

TABLE II. — *Potatoes on Different Soils, Lander, 1893.*

VARIETY.	Yield per acre, Plat I.	Yield per acre, Plat II.	Increased yield on Plat II.
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
Beauty of Hebron	9578	23628	13950
Early Mayflower	15060	28842	13782
Early Puritan	12702	32340	19638
Empire State	15372	22698	7326
Late Puritan	18858	26742	7884
Pride of the West	5040	23322	18282
Snow Drop	14562	25500	10938
White Elephant	11808	27990	16182
Average	12886	26383	13498

*See Soil Analyses in Bulletin No. 6, May 1892.

SUB-SOILING FOR POTATOES.

An acre plat was selected upon each of the experiment farms and one-half of it sub-soiled in the spring of 1896. With the exception of the sub-soiling the whole plat was treated in the same way. So far as the conservation of soil moisture is concerned the benefits of sub-soiling are not usually so apparent until the second and third seasons. But the gains in potato yields were so marked on the sub-soiled land that they are reported here. The potatoes planted on the sub-soiled plat on the Laramie farm did not come up, because of wet, cold weather.

SUB-SOILING FOR POTATOES, SHERIDAN, 1896:

—The land was plowed eight inches deep and sub-soiled twelve inches deep. The potatoes were planted May 12th at the rate of 700 lbs. per acre. Those on the part of the plat not sub-soiled were ripening at the time of frost, Sept. 19th, while those on the sub-soiled land were still green. One variety was grown, the results of which are given in Table III. Twenty-one per cent more potatoes were produced on the sub-soiled ground, and they were larger. This would bring an additional return amounting to about three times the expense of sub-soiling if only one-half cent per pound were received for the crop. In addition it is expected that the land sub-soiled will be in a much better condition the next year.

TABLE III.—*Sub-soiling Land for Potatoes, Sheridan, 1896.*

VARIETY.	Yield on land subsoiled.	Weight of largest 12, subsoiled.	Yield on land not subsoiled.	Weight of largest 12, not subsoiled.	Gain in yield, subsoiled.
Koshkonong.....	<i>lbs.</i> 12860	<i>lbs.</i> 6.5	<i>lbs.</i> 10620	<i>lbs.</i> 6	<i>Per cent.</i> 21

SUB-SOILING FOR POTATOES, SUNDANCE, 1896:

—Table IV gives the results with seventeen varieties at Sundance. They were planted May 8th, at the rate of 680 lbs. of seed per acre. One variety, the Polaris, gave a larger

yield on land not sub-soiled, the deficiency amounting to ten and five tenths per cent, indicated in the table by a minus sign. Late Puritan gave the same yield on both kinds of ground, while the Rural Blush gave one hundred and thirty-seven per cent more on sub-soiled land. The average gain for seventeen varieties is eighteen and one-half per cent, which would much more than pay the expense of sub-soiling, even at the low price of one-half cent per pound for the crop.

TABLE IV.—*Sub-soiling Land for Potatoes, Sundance, 1896.*

VARIETY.	Yield on land subsoiled.	Yield on land not subsoiled.	Per cent gain due to subsoiling.
	<i>lbs.</i>	<i>lbs.</i>	
Arizona	11480	9240	24.0
Bill Nye	10080	8120	24.0
Boston Red	10780	9520	13.0
Clark's No. 1.	7840	7700	2.0
Delaware	10500	8120	29.0
Early Northern	11340	10080	12.5
Late Puritan	4340	4340	0
Morning Star	12320	9680	27.5
Pearl of Savoy	9100	7140	27.5
Polaris	7140	7880	-10.5
Pride of the West	8540	6440	32.6
Rural Blush	5820	2240	137.5
St. Patrick	7000	5740	22.0
Vanguard	5740	5180	10.8
White Elephant	10080	8400	20.0
White Star	7560	7140	5.8
World's Fair	5320	4800	8.5
Average.	8490	7173	18.5

SUB-SOILING FOR POTATOES, WHEATLAND, 1896:—The potatoes were planted May 11th at the rate of 680 lbs, per acre. No difference was noticed in the time of bloom or the time of maturity between sub-soiled land and that not sub-soiled. They came into bloom July 29th, and were ripe October 10th, maturing in one hundred and twenty-two days. One variety was planted. The results are given in Table V. Larger potatoes were produced on the land sub-soiled, the gain on subsoiled ground of marketable potatoes amounting to 18½ per cent, which with the yields obtained and the market price of 50 cents per hundred would hardly pay the expense of subsoiling the first year.

TABLE V.—*Subsoiling Land for Potatoes, Wheatland, 1896.*

VARIETY.	SUBSOILED.				NOT SUBSOILED.				Per cent gain in yield on sub-soiled land.
	Total yield per acre.	Yield per acre marketable.	Per cent marketable.	Weight of largest 12	Total yield per acre.	Yield per acre marketable.	Per cent marketable.	Weight of largest 12.	
Triumph.....	lbs. 3160	lbs. 1984	62.8	lbs. 13	lbs. 2560	lbs. 1760	68.8	lbs. 10.2	18.4

FERTILIZERS FOR POTATOES.

The question of fertilizers for potatoes in this state is not a difficult one to meet. Analysis of our soils show that they contain comparatively large quantities of the essential mineral plant foods. (See Bulletin No. 6, 1892.) Our upland soils are deficient in vegetable molds or humus, which contains nitrogen. This deficiency can be remedied by green manuring, especially with alfalfa, peas, or other leguminous crops, or by applying stable manure. It has been shown in other places that the addition of potash fertilizers, such as kainit, even where large quantities of potash are already found in the soil, will greatly increase the yield of potatoes. We are unable to report such an experiment at this time. However, good crops of potatoes can be raised upon many of our virgin soils, and we do not recommend that our farmers go to the expense of purchasing commercial fertilizers for this crop. The value of vegetable mold in a soil is indicated somewhat by Table II on page 6, where the yield on bottom lands containing humus was over one hundred per cent higher than the yield obtained on upland soil.

FERTILIZING WITH BONE-MEAL, LARAMIE, 1895:

—Three varieties were planted with bone meal, using at the rate of one thousand pounds of bone meal per acre. The potatoes were dropped into the furrow, and the bone meal spread along over them before covering. They were planted on the same soils as those reported in the first part of this

bulletin. (See Table I.) In the variety test these varieties were planted on the same kind of land, but the seed was treated for scab with corrosive sublimate. With the exception of these three varieties planted with bone-meal, few of the potatoes planted without first treating the seed came up, as the seed rotted in the ground on account of cold weather and too much water. On this account those planted with bone meal and not treated with corrosive sublimate are not comparable with the same varieties without bone meal, the seed of which was treated. The fact is of interest, however, that planting untreated seed with bone-meal secured a stand and small yield, while all other untreated seed planted without bone-meal failed to grow. Table VI is given to show the effect of bone-meal compared with seed of other varieties not treated, most of which rotted in the ground, and with the same varieties, the seed of which was treated with corrosive sublimate. The yields given are marketable potatoes in sacks of 100 lbs. each. "Per cent m." means the per cent of the crop which was fit for market. The corrosive sublimate effectually prevented wet rot of the seed. The principal effect of the bone meal seemed to be to prevent enough of the seed from rotting in the ground to secure a partial stand.

TABLE VI.—*Potatoes with Bone-Meal, Laramie, 1895.*

		MILLET GROUND		TIMOTHY GROUND		CLOVER GROUND		WHEAT GROUND		AVERAGE.	
		Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.
Alexander Prolific	Without treatment	None	ca	me	up.						
	Bone meal.....	57	87	44	77	38	75	65	90	46	81
	Treated for scab...	117	91	107	86	128	92	112	92	116	86
Chas Downing	Without treatment	None	ca	me	up.						
	Bone meal.....	61	91	25	92	34	86	19	77	36	80
	Treated for scab ..	132	88	118	83	107	85	94	79	117	86
Koshkonong	Without treatment	None	ca	me	up.						
	Bone meal.....	80	92	82	81	57	92	77	82	74	88
	Treated for scab ..	118	89	141	95	100	85	86	84	117	91

GREEN-MANURING FOR POTATOES, LARAMIE, 1896:—In 1895 an acre plat was planted with millet, field peas, and spring rye. The millet produced no crop, and the ground it occupied was practically fallow, as the weeds more than equalled the millet and the soil remained nearly bare. The peas produced a good heavy crop. They were plowed under eight or nine inches on Aug. 13, when the peas in the pod were green and small. A few peas which were allowed to ripen at one end of the plat yielded at the rate of 13.4 bushels of dried peas per acre. The rye was plowed nine inches deep on July 16th, when fully headed. The straw was heavy, and not all of it was fully covered. The rye yielded at the rate of 2,785 lbs. dried straw and grain per acre. Fifty varieties of potatoes were grown on each kind of ground. The average yield, per cent marketable, and weight of largest twelve tubers is given in Table VII. Comparing the rye and peas plowed under with the millet ground, which was practically without a crop, with potatoes at one cent per pound, it gives the peas a value of \$31 per acre, and rye a value of \$19 per acre as a green manure for potatoes.

TABLE VII.—*Green-Manuring for Potatoes, Laramie, 1896.*

AVERAGE OF FIFTY VARIETIES.	Millet plowed under.	Peas plowed under.	Rye plowed under.	Total.
Yield per acre in pounds marketable potatoes.....	8044	11129	9949	9411
Per cent marketable.....	87.3	90.3	91.1	88.9
Average weight of largest 12 in pounds.....	5.7	6.5	5.8	7.3

Insect Enemies and Diseases of Potatoes.

INSECTS.

THE COLORADO POTATO BEETLE (*Doryphora decemlineata*) causes some damage at the lower altitudes in our state, where they must be kept in check. The poison which is generally used to kill the beetles is Paris green.* It may be applied dry by being thoroughly mixed with air-slacked lime, land plaster, or flour and sifted on the vines. One pound of the Paris green to fifty or seventy-five of the diluent is as strong as it should be applied. The best time to sprinkle the vines with the dry powder is early in the morning when there is no wind and when the vines are damp with dew, or just after a light shower.

The most satisfactory method of applying Paris green is mixing it with water, one pound of poison to two hundred gallons of water. Keep the solution mixed, as the Paris green is heavy and settles to the bottom. It should be applied to the vines in a fine spray. There are many appliances on the market for doing this. I have seen very good work done with a whisk broom by dipping it into the liquid and sprinkling the vines with a quick shaking movement. Still better work can be done with a cheap syringe made for the purpose, while, of course, the most effective and convenient method, where large areas are to be treated, is to use some of the more modern spraying pumps which keep the liquid well mixed and with which two or more rows can be sprayed at once. The same method will be effectual in destroying the

*See Bulletin No. 7, July 1892, on "Insecticides."

black blister beetle which has been reported as working on potatoes in this state.

The potato beetle has never been injurious on the Laramie plains, and so far as I know only occasional adult beetles have been observed. In six years I have not seen more than a dozen specimens here, and never in the larva state. Other plants than the potato, as the wild tomato, on which the beetles sometimes live, are abundant on the Laramie plains, but our conditions, fortunately, do not seem favorable to the multiplication of the pest.

UTAH CRICKET.—At Lander the “Utah” or “Salt Lake” crickets* were quite destructive to the potato tops in 1894. The only methods of combating them successfully seem to be the ones that are generally used for destroying grasshoppers. Last season they were not reported as destructive.

POTATO MAGGOT.—The larva of a small fly† has done some damage to the tubers before they are dug, on the Laramie Farm. They have rapidly increased during the past two seasons. These larva are about one-half inch long and occur in great numbers in the soil. They eat the living tubers. Sometimes potatoes are found two-thirds of which have been consumed, the opening made being completely filled with the maggots. Should they continue to increase it will be necessary to determine some method of checking their ravages. The flies come out early in the spring, during April and May. When plowing the ground great numbers of them are found burrowing in the soil. The larva pupate late in the fall and it is probable that deep plowing as late as it could be done would greatly reduce their numbers by bringing them near the surface where the dry, cold weather would be fatal to them.

*This is a new species not yet named.

†The name of this fly has not yet been determined for lack of examination and study, but it appears to belong to the family *Bibionidae*.

POTATO SCAB.*

This disease is found wherever potatoes are grown, and we regret to state that many of our potato growers are indifferent in regard to it until the disease becomes so abundant as to practically destroy their crop. Our best farmers will not allow potato scab to be introduced into their soils if they can prevent it. Scab is produced by a fungus plant growing on the potatoes. This fungus grows from spores, and unless these spores are placed in the ground by planting infected seed, no scabby potatoes will be produced. If the seed potatoes show any scab they should be treated to kill all the spores before the seed is planted. If a piece of land has produced scabby potatoes the season before, or even two seasons before, it is better to plant to some other crop, as the scab is apt to remain in the ground several years. The treatment is very simple. It consists of immersing the seed potatoes, before they are cut, in a solution of fifteen gallons of water and two ounces corrosive sublimate, for one and one-half hours. When they are dry, cut and plant. Use only *wooden* barrels to contain the solution. Do not use the barrels which have held the solution or the sacks in which the treated potatoes have been placed for anything else, as corrosive sublimate is a deadly poison.

TREATING POTATOES FOR SCAB, LANDER, 1894.

—It appears from this experiment that treating for scab may sometimes be detrimental to the crop. Twelve varieties were planted in rows side by side. One row of each variety was planted with seed which had been treated by dipping into a solution of corrosive sublimate and one row planted with seed not treated. Only one variety gave a larger yield from the treated seed.

The superintendent, Mr. Meyer, reported that there was a little scab on nearly all the seed planted, but there was no scab to speak of on the potatoes raised from either the treat-

*See Bulletin No. 21, January 1895, "The Grain Smuts and Potato Scab."

ed or untreated seed. The potatoes treated took longer to come up and did not seem to do as well at any time through the season as those not treated. Table VIII gives the results. The average yield of the twelve varieties was 118 bushels per acre from treated seed and 172 bushels per acre from the seed not treated. It is likely that something in the treatment of the seed produced these results. Any one of several circumstances may have caused the trouble. If the seed potatoes were left too long in the solution, or the solution was too strong, or if the potatoes were kept too long after treatment before they were planted their vitality might have been so reduced as to injure the crop.

TABLE VIII.—*Treating for Scab, Lander, 1894.*

VARIETY.	YIELD PER ACRE.		Weight of largest lb.
	Seed treated.	Seed not treated.	
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
Early Rose.....	7572	7740	7.5
Early Mayflower.....	12030	16878	7.5
Early Puritan.....	6120	8580	7.5
White Elephant.....	10602	13212	11.0
Snow Drop.....	3482	8340	7.5
Empire State.....	6702	11064	8.0
Bill Nye.....	10134	11232	7.5
Late Puritan.....	5502	9138	8.0
Beauty of Hebron.....	6204	13306	8.5
Triumph.....	5358	9132	8.5
Jumbo.....	7320	11220	10.0
Vanguard.....	3042	2760	7.5

TREATING FOR SCAB, LARAMIE, 1895.—This experiment shows quite a different effect of treating the seed with corrosive sublimate than that obtained upon the substation at Lander. Table IX gives the comparative results of treating the seed of nine varieties. The most noticeable effect of this treatment was to prevent the seed rotting in the ground during the cold, wet weather which followed planting. Seed-potatoes of fifty varieties were treated, all of which came up well and produced good yields. Of the nine varieties planted without treating the seed, only the White Elephant made a good stand and reference to the table will

show that this variety gave a larger yield and less scab from the treated seed. The per cent of scab was computed from all the potatoes produced whether there were enough growing to warrant computing the yields or not. The number of potatoes which were affected with scab divided by the total number of tubers gave the percent scab given in the table. There was not enough scab on any of the potatoes from treated seed to hurt them commercially while many of the potatoes from untreated seed were so badly affected as to make them unfit for market. In this experiment the seed potatoes were treated by placing them in a solution of corrosive sublimate made by dissolving two ounces of the poison in 15 gallons of water. They were left in the solution for one and one-half hours, after which they were spread out to dry and cut the same day they were treated. The seed potatoes not treated were also cut at the same time and both treated and untreated tubers were planted the day after they were cut. Attention is called to the fact that the difference in yields between treated and untreated seed is due mainly to the difference in the amount of the seed that grew, while difference in the amount of scab must be due to treatment.

TABLE IX.—*Treating for Scab, Laramie, 1895.*

VARIETY.	SEED TREATED.			SEED NOT TREATED.		
	Yield.	Per cent marketable.	Per cent scab.	Yield.	Per cent marketable.	Per cent scab.
	<i>lbs.</i>			<i>lbs.</i>		
Burpee's Superior.....	10520	88	2	.....	.....	51
Clark's No. 1.....	10756	79	Trace	.....	.....	22
Early Norther.....	9615	85	Trace	.....	.....	32
Monroe's Seedling.....	9765	85	Trace	4330	85	28
Reed's No. 86.....	6795	78	None	2445	85	4
Rose Seedling.....	7440	90	Trace	2197	96	8
Vanguard.....	7275	84	7	None	came	up.
White Elephant.....	7207	82	Trace	6810	82	4
World's Fair.....	8077	88	None	None	came	up.

POTATO BLIGHT.

We are unable to offer positive evidence that true potato blight has caused injury to the potato crop in Wyoming. The superintendents of the experiment farms have believed their potatoes were more or less damaged by the blight but I have not observed any fields affected with the fungus known to produce this disease.*

Other causes may make the vines appear to be affected with blight, but if it is certain that the blight is causing the injury, experience in other places indicates that some benefit may be derived from spraying the vines with Bordeaux mixture.

Methods of Preparing Seed Potatoes.

Much might be said concerning the selection as well as the preparation of potatoes for planting. A favorable climate and soil, together with the selection of the best potatoes for seed, should continually improve a variety. In some places, however, potatoes "run out." By "running out" it is meant that the tubers so deteriorate in size, shape, smoothness and quality as to decrease the value of the crop. Where the tubers run out badly, it may be necessary to obtain seed from some other locality every year or at least every few years to keep up a high standard of excellence in the crop. It is never profitable to plant poor seed, and this is especially true with potatoes where the seed is poor from deterioration of the crop under the same conditions.

Generally speaking the potatoes we have grown upon the experiment farms have not shown a tendency to run out, at least to any noticeable degree. There seems to be

*For the nature of these fungi see Bulletin No. 21 of this Station.

considerable difference in varieties in this respect. Under the same plan of selecting the seed some few varieties have deteriorated, while others, and I think the majority of them, have improved. Only one variety has continually produced poorer potatoes than the seed planted. This is the Empire State. The tubers show a tendency to elongate and become pointed at the stem end, which injures their shape for market. In those parts of the state where our experiments have been conducted, most varieties can be grown year after year in the same place without the necessity of renewal by obtaining seed potatoes from some other locality. In fact, using the small potatoes from the preceding crop for seed is often resorted to without the casual observer noting any difference in the resulting crop. That poorer potatoes are actually produced than would be the case if the best tubers were selected for seed will be shown later. There is no doubt that "blood tells" with potatoes as well as with other plants or with animals and the proper way to work up the seed of a variety of potatoes to produce the finest crops is to select always the very best in size, shape and general quality for the mother potato. The fact that good crops have been produced for several years by planting potatoes which were too small for market has led many to believe in the practice. That better crops are actually produced where better potatoes are selected for seed is shown in our experiments in planting whole and cut seed. In each case the potatoes planted whole were small tubers, while those cut were large. In no instance has the crop from the cut seed been as large as that produced from the small potatoes planted whole. This is no doubt due to the greater vitality of the whole potatoes, together with their ability to withstand too dry or too wet weather because better protected by their skin covering. However, in no case was there so large a per cent of the crop fit for market from the small tubers planted whole as there was from the large potatoes cut before planting. At Laramie in 1896, 79.3 percent of the crop

from small tubers of Rural Blush was marketable, while 86.3 percent of the crop from large potatoes was marketable. Of the Early Rose crop, small tubers planted whole produced 83.4 percent marketable potatoes, while large tubers cut produced 93.4 per cent marketable. At Wheatland in 1893 three percent less of the total yield was fit for market of the crop from small potatoes planted whole. At Lander in 1894 about one percent less of the total crop was marketable from the small potatoes.

If such deterioration takes place the first year small potatoes are planted, it is probable the difference would be much greater if the practice of planting small potatoes raised from small potatoes were carried out. However if these small potatoes have been produced from planting good seed there is no question that larger crops may be obtained for a season or two by planting them whole.

WHOLE VS. CUT SEED, LANDER, 1894:—In Table X. the crop produced from twenty pounds of small potatoes planted whole is compared with the average crop from seven different methods of cutting the seed, the same amount being planted in each case.* The yield in the table is the number of pounds produced from twenty pounds of seed. About one percent less of the total yield was marketable from the whole seed, but the gain in yield of marketable potatoes from whole seed is twenty-seven and one-half percent.

TABLE X. — *Whole vs. Cut Seed, Lander, 1894.*

VARIETY.	WHOLE SEED, 20 LBS.			CUT SEED, 20 LBS.			Gain with whole seed, per cent.
	Total yield.	Yield marketable.	Per cent marketable.	Total yield.	Yield marketable.	Per cent marketable.	
Pride of the West	lbs. 310	lbs. 278	89.7	lbs. 241	lbs. 218	90.4	27.5

*The different ways of cutting the seed here referred to are compared in this report under the heading "Different Ways of Cutting Seed, Lander, 1894," which see.

WHOLE VS. CUT SEED, LARAMIE, 1895.—Seed of the Rose Seedling potato was selected and prepared in five different ways. One hundred and thirteen small potatoes amounting to nine pounds and three ounces were planted whole, and the same weight of larger potatoes was cut in each of the following ways: Cut in half lengthwise; cut two eyes to each piece; cut one eye to each piece; and lastly pared comparatively deep, the parings with one eye on each piece planted. As before stated but little of the seed planted in 1895 without first being treated, came up. In this experiment 96 percent of the potatoes planted whole came up, 40 percent of those cut in half lengthwise, 5 percent of those cut two eyes to the piece, and less than one percent of those cut one eye to the piece or planted as parings. On account of the small number of plants occupying the land the experiment was abandoned after determining the percent of each which grew.

WHOLE VS. CUT SEED, LARAMIE, 1896.—The great difference in the yields here (see Table XI.) evidently is due to planting the potatoes in ground that was too dry. The dry soil coming in contact with the cut seed drew out the moisture and the most of it failed to grow. The vitality of the cut seed which did grow was so reduced that the vines were not as large or thrifty throughout the season as were those from the whole potatoes.

TABLE XI.—*Whole vs. Cut Seed, Laramie, 1896.*

VARIETY.	WHOLE SEED.			CUT SEED.		
	Total yield.	Yield marketable.	Per cent marketable.	Total yield.	Yield marketable.	Per cent marketable.
	<i>lbs.</i>	<i>lbs.</i>		<i>lbs.</i>	<i>lbs.</i>	
Early Rose.....	14230	11867	83.4	3108	2903	93.4
Rural Blush.....	10824	8583	79.3	5877	5077	86.3

WHOLE VS. CUT SEED, SHERIDAN, 1894.—In Table XII. are given the yields of ten different varieties from whole and cut seed with the increase in yield from the whole potatoes. No notes of the amounts of seed planted or of the percent of the crop which was marketable are available. The yields here are given in sacks of one hundred pounds each. White Elephant gave a larger yield from cut seed but the average increase in the crop from the whole seed is ten percent.

TABLE XII.—*Whole vs. Cut Seed, Sheridan, 1894.*

VARIETY.	Whole. yield per acre.	Cut. yield per acre.	Gain in yield with whole seed.
	<i>cwt.</i>	<i>cwt.</i>	<i>per cent.</i>
Vanguard	131.9	118.9	11
Empire State	156.0	145.0	8
Iron Clad	156.6	139.2	12
Bill Nye	130.3	117.4	16
White Elephant	113.1	116.0	—3
Early Rose	137.7	131.9	4
Hotel Favorite	160.9	150.8	6
Beauty of Hebron	155.1	145.0	7
Marquette	162.4	129.0	26
Snow Drop	145.0	130.4	11
Average	145.6	132.4	10

WHOLE VS. CUT SEED, WHEATLAND, 1893.—This experiment, which is reported in Table XIII, presents the most complete and valuable data at hand on this subject. The difference in the amount of seed per acre with cut and whole seed is not great and as the hills were planted about the same distances apart the difference in weight merely indicates the difference in the size of the pieces planted. Practically all the whole potatoes planted, grew. The last column in the table gives the percent of the cut seed which failed to grow. This enables the reader to make comparisons between the whole and cut seed where all of both came up. The whole seed was selected from the small potatoes not fit for market while the cut seed was of average sized

tubers cut two eyes to each piece. Thirteen and six-tenths percent more potatoes were produced from the whole seed.

TABLE XIII.—*Planting Whole Potatoes vs. Cut Seed, Wheatland, 1893.*

VARIETY.	WHOLE SEED.				CUT SEED.				
	Seed per acre	Yield per acre.	Per cent fit for market.	Weight of largest 12.	Seed per acre.	Yield per acre	Per cent fit for market.	Weight of largest 12.	Per cent which failed to grow.
Beauty of Hebron.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Bill Nye	780	8230	60	6.5	494	4964	75	7.0	0
Early Mayflower	838	8170	70	7.0	492	7220	80	7.5	10
Early Ohio	648	7220	75	7.0	570	4560	60	7.1	20
Early Puritan.	684	5320	80	7.5	532	2472	75	7.3	40
Early Rose	608	7448	75	7.3	570	4370	80	7.0	40
Empire State.	722	7220	75	9.2	608	2470	75	7.3	40
Gov. Rusk	874	8034	75	8.0	522	4484	80	7.5	0
Hoffman	760	8664	80	11.0	455	7600	80	11.5	0
Jumbo.	608	7940	80	13.0	455	6440	85	13.1	10
Late Puritan	675	8818	80	13.8	532	7000	80	13.0	0
Mammoth Pearl.	830	7940	70	7.5	494	5016	80	7.0	20
New Burbank	798	11400	80	14.0	722	8550	80	14.5	10
Pride of the West.	798	8240	70	8.1	340	6460	75	7.0	30
Rose Seedling.	984	7236	60	8.0	604	6250	75	7.2	0
Snow Drop.	874	10496	80	12.6	532	6250	80	13.1	15
Triumph	448	6840	50	6.0	418	6650	65	7.0	0
Vanguard	456	6040	60	7.6	456	4750	65	7.0	10
White Elephant.	798	9500	85	15.1	418	8626	85	16.0	0
	608	8258	85	12.6	522	7600	80	11.5	0
Average	725	7982	73	9.6	516	5463	76	9.7	

WHOLE VS. CUT SEED, WHEATLAND, 1894.—Table XIV. gives the amounts of seed per acre and the yields with whole and cut seed and the percent of gain in yield with whole seed. The reason for the great difference in yields between the whole and cut seed is indicated by the weather conditions at the time of planting the seed. The potatoes were planted May 7 when the ground was very loose and dry. They were irrigated on May 30 to bring them up, but the most of them did not come up till the middle of June. Under such conditions the whole seed would retain its vitality and produce much better stands than seed which had been cut.

TABLE XIV.—*Whole vs. Cut Seed, Wheatland, 1894.*

VARIETY.	WHOLE SEED.		CUT SEED.		Gain in yield with whole seed.
	Seed per acre.	Yield per acre.	Seed per acre.	Yield per acre.	
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>per cent.</i>
Early Rose.....	1562	13376	670	7600	76
Early Ohio.....	2090	10636	508	2606	308
Early Mayflower.....	1240	12614	556	10636	20
Early Puritan.....	1330	13034	532	8702	50
Hoffman.....	874	10854	508	6118	79
White Elephant.....	684	20604	570	7486	256
Snow Drop.....	760	9766	484	5016	95
Rose Seedling.....	786	8906	556	4864	85
Empire State.....	824	10300	514	5358	92
Gov. Rusk.....	760	12436	456	7420	68
Bill Nye.....	714	11666	514	4864	140
Late Puritan.....	950	10070	514	6510	55
Pride of the West.....	950	8132	608	4864	65
Beauty of Hebron.....	760	8246	456	7334	12
Triumph.....	1140	10260	644	5340	92
Jumbo.....	1064	12274	646	5510	122
Mammoth Pearl.....	928	15200	570	7600	100
Vanguard.....	874	12386	474	6900	97
New Burbank.....	914	7980	570	5472	46
Average.....	1011	11844	547	6295	88

Some experiments were made upon the home station to see if some such substance as land plaster would not keep the potatoes from drying out by rolling them in it after they were cut, but no results of value were obtained. Under our conditions planting whole seed seems to insure a stand and crop where cut seed will dry out and fail.

DIFFERENT METHODS OF CUTTING SEED POTATOES, LANDER, 1894.—The test reported in Table XV. was made to determine which of the eight methods of cutting the seed would produce the largest amount of marketable potatoes. The total yield given is the number of pounds produced from twenty pounds of seed of Pride of the West potatoes. No. 1, cutting the potatoes in quarters lengthwise leaving one-fourth of the seed end on each quarter, gave the best results, and No. 8, in which the seed was also quartered, gave the second best result. Cutting one eye to each piece, first cutting off the seed end, gave a better result than when the seed end was left on, which would neces-

sitate cutting much smaller pieces. When cut in larger pieces better results were obtained when the seed ends were left on.

TABLE XV.—*Methods of Cutting Seed Potatoes, Lander, 1894.*

TREATMENT.	Total yield.	Large.	Small.
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
No. 1—Cut in quarters lengthwise of tubers, leaving seed ends on . . .	335	308	27
No. 2—Cut same as No. 1. Treated with corrosive sublimate. There was no scab on potatoes from treated or untreated seed, and the treatment seemed detrimental	305	285	20
No. 3—Small potatoes left whole	310	278	32
No. 4—Cut one eye to a piece. Seed end cut off	244	222	22
No. 5—Cut as nearly as possible one eye to a piece and seed end left on	210	190	20
No. 6—Cut in halves lengthwise of tuber. Largest tubers not used	174	151	23
No. 7—Cut in halves lengthwise of tuber. Seed ends cut off. Largest tubers not used	102	84	18
No. 8—Cut in halves lengthwise and each half cut in two crosswise, leaving seed ends on	321	289	32

Cutting the potatoes in quarters lengthwise so as to leave one-fourth of the seed end on each quarter has been practiced at the home station for the past three years and where the seed potatoes are not too large this method of cutting is recommended.

SEEDING AT DIFFERENT RATES PER ACRE, LANDER, 1895.—The number of pounds of seed potatoes used is not given accurately. The records state that seed cut two eyes to the piece and planted sixteen inches apart in the row, amounted to between five and six hundred pounds per acre. Then those cut the same and planted eight inches apart would equal twice this amount. Those cut two eyes to each piece and planted four inches apart would use as much as a ton of seed per acre, and cut one eye to each piece and planted four inches apart about one-half ton per acre. The amount of seed potatoes per acre will depend upon the size of the pieces and the distance the hills are apart. The usual seeding is from four hundred to six hundred pounds per acre, at least where machines are used that drop the seed fifteen to eighteen inches apart in rows three or more feet apart. We believe it pays to use

more seed and plant closer than this. Rows two and one-half to three feet apart allow room for sufficient cultivation, and planting so that hills will stand eight inches apart in the row does not seem to overcrowd the plants, with most varieties. In Table XVI. the seed cut two eyes to each piece, and planted eight inches apart, using about a thousand pounds per acre, gave the best result.

TABLE XVI.—*Cutting Seed Differently and Different Rates per Acre, Lander, 1895.*

VARIETY.	Method of cutting.	Distance apart in rows.	Yield per acre.	Weight of largest twelve.
		<i>inches.</i>	<i>lbs.</i>	<i>lbs.</i>
Empire State	2 eyes	16	11637	11.5
	2 eyes	8	13624	10.0
	2 eyes	4	13192	7.5
	1 eye	4	5049	7.0

SEEDING AT DIFFERENT RATES PER ACRE, WHEATLAND, 1895.—Table XVII. The potatoes were cut two eyes to each piece and planted May 14th. The land was prepared the year before by plowing under a heavy crop of green alfalfa, so that the soil was in excellent condition. However, the yields obtained were unusually small. As all were treated alike the results are comparable, and show the effects of different rates of seeding. In each case that amount of seed which produced hills eight inches apart in the rows gave the largest yields of marketable potatoes. Where planted as closely as four inches apart, the vines were evidently too crowded, as shown by the resulting small percent of tubers that were fit for market. The seed was planted eight inches apart in the rows upon that famous prize acre of potatoes in the northern part of this state, where in competition for the largest yield over 974 bushels were grown on a single acre. (See account on page 38.)

TABLE XVII.—*Different Seeding per Acre, Wheatland, 1895.*

VARIETY.	Amount seed per acre.	Distance apart of hills in row.	Total yield per acre.	Yield market- able potatoes per acre.	Per cent of po- tatoes mar- ketable.	Weight of larg- est twelve.
	<i>lbs.</i>	<i>inches.</i>	<i>lbs.</i>	<i>lbs.</i>		<i>lbs.</i>
Mammoth Pearl	520	17	4400	3432	78	12.6
	736	8	6880	5443	79	12.0
	910	4	5200	2730	52	8.7
Rose Seedling	487	18	3900	3042	78	16.0
	673	8	7375	5605	76	12.5
	840	4	7575	4166	55	10.0

Upon the home station at Laramie the varieties (see part II of this Bulletin) were planted at the rate of 700 to 1,000 pounds per acre. With average sized tubers cut into quarters lengthwise this amount of seed planted the pieces eight inches to twelve inches apart in the row. Our comparatively large yields in 1894 at Laramie is explained by the fact that the rows were only two feet apart, more potatoes being produced on the same amount of land than when the rows are two and one-half or three feet apart. Rows two feet apart are too close, as even at high altitudes the plants grow so large that it is difficult to cultivate without injury to them. In general, early, small topped varieties may be planted closer together than later and larger topped kinds and in localities where the tops grow large it will be necessary to give them more room.

Potatoes at Different Altitudes.

As the conditions vary so materially at the several experiment farms it is not easy to ascertain what differences in the crop are due to difference in altitude. The home station on the Laramie Plains is over 3,000 feet above the substation at Sheridan, but Sheridan being farther north tends to equalize the temperature so the greatest differences in climate are in atmospheric pressure and the range of temperature. The nights are generally cool in all parts of the state and the greater heat during the day at the lower places makes the daily range of temperature less at the higher altitudes. Below is given a comparison of the potato seasons at the different altitudes with the mean annual temperature at each place. The dates given are taken from the reports of potato experiments at each place and are not infallible. Planting early potatoes for an early crop might be done before the dates given, while planting for

TABLE XVIII.—*Comparative Seasons and Altitudes.*

	Time of Planting.	Time of Harvest.	Time of First Killing Frost.	Mean annual temperature,
Laramie, 7200 feet.....	May 10 to June 1	Sept. 20 to Oct. 20	Sept. 1 to Sept. 10	40.1
Saratoga, 6000 feet.....	May 10 to June 1	Sept. 15 to Oct. 1	Sept. 1 to Sept. 20	40.4
Lander, 5500 feet.....	May 1 to May 15	Oct. 1 to Oct. 15	Sept. 10 to Sept. 20	43.7
Wheatland, 5000 feet.....	May 1 to May 15	Sept. 15 to Oct. 1	Oct. 1 to Oct. 15	49.0*
Sundance, 4500 feet.....	April 15 to May 20	Sept. 20 to Oct. 10	Sept. 10 to Sept. 20	41.2
Sheridan, 4000 feet.....	May 1 to May 15	Oct. 1 to Oct. 15	Sept. 10 to Sept. 25	41.5

*Average of two years only.

late shippers might be done after the date indicated. In the column giving the time of first killing frosts the time given only indicates that killing frost may be expected between

these dates. It may come earlier or later. For instance, at Laramie killing frost occurred twice before September 1, and one year it did not come till September 23.

The time between planting and harvesting the crop is almost identical at each place. Early varieties ripen and the tops die down before time of frost, but the tops of the late varieties usually remain green until killed by frost. As a rule, a few varieties have not fully ripened their tubers at Laramie, though all have been sufficiently ripe to keep well through the winter.

YIELDS UPON THE EXPERIMENT FARMS.—Our observations have led us to believe that differences in yields are principally due to favorable or unfavorable soil conditions, and treatment of the crop. We have not been able to show that variations in yield correspond in any way with variations in altitude. However, under this head we publish Table XIX, which gives the yields with average for each place. This table indicates the comparative crops that have been produced in the different sections of the state, and I think a fair estimate of

TABLE XIX.—*Comparative Potato Yields.*

	Yield 1894	Yield 1895.	Yield 1896.	Yield, average
Laramie, 7200 feet altitude.....	12913	10652	10574	11713
Lander, 5500 feet altitude.....	8663	10082	30164	16306
Wheatland, 5000 feet altitude.....	9043	6240	5296	6860
Sundance, 4500 feet altitude.....		7006	6455	6730*
Sheridan, 4000 feet altitude.....	15138	13025	8271	12145
Average for the Stations.....				10750

*Average of two years.

the average potato yield for the state may be taken from it. The table shows the average total yields of potatoes at the five places considered, to be 107 sacks of 100 pounds each, or about 179 bushels per acre. Taking the percent of the total crop which has been marketable in these experiments the average yield of marketable potatoes is about 150

bushels per acre. The average yield of potatoes for the United States is placed at about 100 bushels per acre. (See the Year Book of the Department of Agriculture for 1895.) The same report gives the average yield in Wyoming for the same year 100 bushels per acre.

SPECIFIC GRAVITIES AT LARAMIE AND SUNDANCE.—That there are some differences in potatoes grown at high and low altitudes which are due to the difference in altitude and the consequent climatic conditions is probable. In order to obtain some idea of the quality of potatoes grown at different altitudes the specific gravities of those varieties raised upon the Sundance farm and the Laramie Farm in 1896 were determined. In Table XX we have given also the percent of starch as indicated by the specific gravities. The percents of starch corresponding to the specific gravities as given, were taken from a table in "Foods: Composition and analysis," by Blyth. As has been shown by investigations in other places, especially at the Virginia Station, the specific gravity of a potato is not an accurate indication of its starch content, but it is probable that the percents given do not vary more than two percent from the true amount.* The specific gravity will vary with the variety, the locality, and season and we have noticed considerable variation in a given crop of the same variety. For example, while selecting heavy seed potatoes for planting this season some tubers were found of Burpee's Superior which had a specific gravity of over 1.085 while the specific gravity for this variety given in the table is 1.073. In each variety as far as observed the smaller or medium sized tubers had a greater specific gravity than the larger ones.

The conditions at Laramie and Sundance are notably different. At Laramie the rainfall is about twelve inches per annum, and the potatoes are raised under irrigation,

*Also see "Principles and Practice of Agricultural Analysis," by H. W. Wiley.

while at Sundance the rainfall is about seventeen inches annually and the crops were raised without irrigation. The soils at the two places are also very different, but we believe the difference in altitude and consequent climate may have much to do in determining the specific gravity and percent of starch. It is probable that the starch content of potatoes raised at high altitudes will be less than that from lower altitudes. On this account potatoes raised under irrigation, at least above 6,000 feet, must be most carefully and intelligently handled or they are apt to be poor in starch. Potatoes rich in starch are more mealy and of better quality than those which are poor in starch. The potato crop at Laramie in 1896, on account of some climatic condition or too much irrigation was poorer than usual. Heretofore the potatoes raised upon the Laramie Plains have been of excellent quality and held in high esteem by the people here for table use. Potatoes raised at high altitudes also have been found excellent seed for planting in other places as their vitality and the change to which they are subjected produce beneficial results, giving larger yields and better potatoes.

TABLE XX.—*Specific Gravities and Per Cents Starch at Laramie and Sundance, 1896.*

No.	VARIETY.	LARAMIE.		SUNDANCE.	
		Specific gravity.	Starch, per cent.	Specific gravity.	Starch, per cent.
1.	Acme Seedling.	1.074	12.7	1.102	20.1
2.	Albino.	1.083	14.5	1.098	17.9
3.	Alexander Prolific.	1.085	14.9	1.079	13.7
4.	Arizona.	1.086	14.9	1.100	18.2
5.	Bill Nye.	1.077	13.3	1.092	16.4
6.	Blue Victor.			1.092	14.3
7.	Boston Red.	1.087	15.4	1.101	18.4
8.	Brownell's Winner.	1.083	14.5	1.091	16.2
9.	Burpee's Extra Early	1.082	14.3	1.095	17.1
10.	Burpee's Superior	1.073	12.5		
11.	Charles Downing	1.071	12.1	1.099	17.9
12.	Chicago Market.	1.077	13.5		
13.	Clark's No. 1	1.084	14.7	1.096	17.3
14.	Dakota Red.	1.084	14.7	1.089	15.8
15.	Delaware	1.081	14.1	1.085	17.1
16.	Early Market			1.099	17.9
17.	Early Minnesota.	1.078	13.5		
18.	Early Northern.	1.089	15.8	1.103	18.8
19.	Early Ohio	1.090	13.9	1.100	18.2
20.	Early Rose	1.079	13.7	1.102	18.6
21.	Early Six Weeks.	1.075	12.9	1.106	19.4
22.	Early Sunrise	1.076	13.1	1.102	18.6
23.	Empire State	1.076	13.1	1.089	15.8
24.	Freeman	1.080	16.0	1.091	16.2
25.	Koshkonong.	1.071	12.1	1.089	15.8
26.	Late Puritan.	1.078	13.5	1.086	15.1
27.	Mammoth Pearl	1.074	12.7	1.082	14.3
28.	Manitoba Rose	1.087	15.4	1.099	17.9
29.	Montana Wonder	1.083	14.5		
30.	Monroe's Seedling.	1.074	12.7	1.095	17.1
31.	Morning Star.	1.082	14.3	1.106	19.9
32.	New Queen	1.084	14.7	1.092	16.4
33.	Ohio Junior	1.081	14.1	1.096	17.3
34.	Ohio Red.	1.081	10.1	1.124	23.3
35.	Pearl of Savoy	1.081	14.1	1.098	17.7
36.	Polaris.	1.082	14.3	1.106	19.9
37.	Pride of the West	1.071	12.1	1.081	14.1
38.	Reed's No. 80	1.076	13.1	1.101	18.4
39.	Rochester Rose	1.077	13.3	1.101	18.4
40.	Rose Seedling	1.076	13.1	1.085	14.9
41.	Rural Blush	1.081	14.1	1.089	15.8
42.	Rural New Yorker.	1.084	14.7	1.087	15.4
43.	Snow Drop	1.073	12.5		
44.	St. Patrick.	1.086	15.1	1.089	15.8
45.	Summit.	1.072	12.3	1.096	17.3
46.	Thornburn.	1.090	13.9	1.090	16.0
47.	Vanguard.	1.083	14.5	1.111	20.5
48.	White Elephant	1.081	14.1	1.088	15.8
49.	White Star.	1.086	15.1	1.090	16.0
50.	World's Fair.	1.085	14.9	1.093	16.6
Average.		1.081	14.1	1.096	17.3

Planting, Cultivation and Irrigation.

The months of heaviest rainfall in Wyoming are May and June, which generally give sufficient water supply to the soil to bring up all crops, but it is necessary to carefully conserve soil moisture. Some seasons, however, may be too dry, when it is best to irrigate before the land is plowed. The customary manner of planting is, first to well plow the land, then furrow with a plow, drop the potatoes and cover with a plow or "V." After planting, the ground should be thoroughly harrowed. It is important that the potatoes be dropped, covered and harrowed as soon as possible after the land has been furrowed. An experiment in 1896 upon the Laramie Farm demonstrates this in a conclusive manner. All the land was furrowed and several varieties were dropped and covered at once, before the soil had dried out, on May 13. Two days later some varieties were planted in the remaining furrows and after being covered the entire plat was harrowed. Those planted first made a good stand, practically all the seed growing. Of those planted after the furrows had dried out for two days only a few grew, possibly about ten percent.

The slight depressions left between the rows when potatoes are planted in this way may be of use should it become necessary to irrigate the potatoes up, a course which should never be resorted to unless absolutely necessary. Another method of planting which is quite extensively practiced upon the Laramie Plains is to drop in every third furrow while the land is being plowed. The advantage of retaining all the moisture possible is gained in this way, but on the other hand the plowing must necessarily be shallower than it otherwise might be, and unless the land has been well

plowed some time previously it is to be doubted whether it is the best method. However, where careful preparation is given beforehand this method is recommended.

Where care is taken to keep the soil moist and in good condition it will rarely be found necessary to irrigate the potatoes after they are planted to bring them up. Where irrigation for this purpose is unavoidable, shallow furrows should be made between the rows so that the land may be irrigated rapidly and without flooding. But little water will be necessary, at this time, and the less applied the less will be the cooling effect upon the soil.

About the time the potatoes are coming up they should be harrowed, preferably with the teeth of the harrow slanted backward to avoid cutting the young shoots. This is to kill the small weeds and also to break the crust forming a dust mulch on the surface which prevents evaporation. As soon as the crop is nicely up cultivation should begin and should be continuous till the plants are in bloom. It is best to give level cultivation, not banking the vines too much until just before irrigation when it will be necessary to make furrows between the rows in which to run the water.

The time to irrigate potatoes and the amount of water to be applied depends largely on the conditions of soil and climate and can only be determined by experience. A general rule to follow which will apply to most varieties is not to irrigate till the plants are in full bloom. From what observations we have made on this point we are led to believe that in general the potatoes set about ten days before they begin to bloom. Then if irrigation begins at the time of bloom, the sets having been formed, nearly all the tubers will grow to a marketable size, while, if irrigated earlier too many small potatoes will be set on the vines and few will reach a good size.

The first irrigation should be a thorough one, com-

pletely soaking the lower soil. After irrigating begins, the soil should not be allowed to dry out, as there is danger of the growth of the tubers being checked, and when wet again, of their starting to set small tubers a second time, or of sprouting to grow. In either case a failure of the crop might result. The furrow system of irrigation should invariably be practiced with potatoes. Never flood them or allow the water to reach the crown of the plants. After each irrigation as soon as the surface dries off and before it begins to bake, shallow cultivation should be given to break up the crust, keep the land mellow and a mulch of loose soil upon the surface.

It is better to avoid irrigating during hot, sultry weather, for if allowed to get too dry, the potato plants are weakened, and when irrigated at such a time good conditions for the attack of fungus diseases, such as blight, will prevail. Potatoes do not need a great amount of irrigation. They should not be allowed to suffer with drouth, but while better crops are produced with judicious irrigation the crop is often seriously injured by haphazard application of water. Do not irrigate too often or too late. In the driest seasons three or four irrigations will generally be sufficient in any part of the state. The crop should be developed far enough by the middle of August for both irrigation and cultivation to cease.

Cost and Profit With Potatoes.

LARAMIE, 1894. —Cost per acre, including, fertil-	
izer, seed, labor, etc.....	\$50 00
Average yield of fifty varieties,	
118.4 sacks.	
Value of crop at 1c per pound...	118 40
Net profit per acre.....	
\$68 40	
LARAMIE, 1895. —Cost per acre.....	
\$35 00	
Average yield of fifty varieties,	
89.0 sacks per acre.	
Value of crop at $\frac{1}{2}$ c per pound...	44 50
Net profit per acre....	
\$ 9 50	
LARAMIE, 1896. —Cost per acre.....	
\$31 50	
Average yield of fifty varieties,	
91.4 sacks per acre.	
Value of crop at $\frac{1}{2}$ c per pound...	47 05
Net profit per acre.....	
\$15 55	
Average net profit at Laramie for three years with	
fifty varieties....	
\$31 15	
LANDER, 1894. —Cost per acre.....	
\$32 50	
Average yield of twelve varieties	
from treated and untreated seed.	
86.88 sacks per acre.	
Value of crop at 1c per pound....	86 88
Net profit per acre.....	
\$54 38	
LANDER, 1895. —Cost per acre.....	
\$33 50	
Average yield of thirteen varieties,	
66.66 sacks per acre.	
Value of crop at $1\frac{1}{2}$ c per pound...	83 32
Net profit per acre.....	
\$49 82	

SUNDANCE, 1895.—Cost per acre.....	\$15 00
Average yield of thirty-six varieties, 70 sacks per acre.	
Value of crop at $\frac{1}{4}$ c per pound..	52 50
Net profit per acre.....	\$37 50
WHEATLAND, 1894.—Cost per acre.....	\$30 50
Average yield of nineteen varieties, 90.3 sacks per acre.	
Value of crop at 1c per lb....	90 30
Net profit per acre.....	\$59 80
WHEATLAND, 1895.—Cost per acre.....	\$28 00
Average yield of thirty varieties, 44.1 sacks per acre.	
Value of crop at $\frac{1}{4}$ c per lb....	22 05
Loss per acre.....	\$ 5 95
WHEATLAND, 1896.—Cost per acre.....	\$24 00
Average yield of forty-five varieties, 32.2 sacks per acre.	
Value of crop at 85c per hundred.....	27 37
Net profit per acre.....	\$ 3 37
Average net profit per acre at Wheatland for all varieties grown and three years.....	\$19 10

The above estimates of cost and profit with potatoes are based upon the reports of the superintendents of the experiment farms, and the cost given in most cases is an estimate of the actual cost of raising the potatoes grown in the experiments. Where actual cost is given it is high, for in the first place experimentation is expensive, and in the second place very small areas were grown, an acre or less in each experiment. Where small acres are grown the cost per acre would be more than upon larger areas. On the other hand, the small areas of potatoes grown for experiment would

probably produce larger yields as a rule than the yield upon larger areas, which would make the profit greater. At Lander in 1896 such small areas were grown of each variety that computing the yields per acre was not justifiable, at least for this purpose, so we have not made an estimate of cost and profit. The apparent large yields from these small areas makes the profit per acre amount to over \$150. The average yield of so many varieties is lower than the yield from any of the better kinds. The last two seasons at Wheatland several of the varieties either produced very small yields or failed altogether. Averaging these in with the others made the yield so small that the crop grown in the experiment in 1895 cost more than it was worth at the local market price. The value of the crop is computed from the yield and the local wholesale market price for each place and year. Estimated cost and profit is not given at Saratoga or Sheridan, and for only one year at Sundance, as the estimated cost per acre and market price of crops were not given in reports from those places.

We believe that on large areas the total expense of raising and marketing a crop of potatoes under irrigation should not ordinarily exceed thirty dollars per acre. Taking our indicated average yield of 150 bushels per acre and an average price of one-half cent per pound, gives an average net profit of fifteen dollars per acre. The relation of potatoes to other crops on the farm, their place in the rotation of crops, and the favorable condition in which the soil is left by potatoes, together with a net profit of fifteen dollars or more per acre, gives them a high rank among our field crops.*

*For estimates of cost and profit with wheat in Wyoming, see Bulletin No. 25, Wyoming Station.

A Famous Authentic Yield of Potatoes in Wyoming and How It Was Obtained.

In answer to a letter to Mr. Herbert Myrick, editor of that standard and progressive agricultural paper, the "American Agriculturist," we have received the following account of a prize acre of potatoes grown upon the farm of Mr. Sturgis, in 1890. Mr. Sturgis' farm is situated upon the "Little Piney" creek in the northern part of the state. On account of its authenticity and value, along with the information in regard to methods of planting and raising potatoes, and to make it a matter of history in the state, the statement as received is published in full. The account appeared in "The American Agriculturist" for December, 1890.

"THE FIRST PRIZE CROP."

"Where it was grown.—Buffalo, in northern Wyoming, Johnson County, about latitude $44\frac{1}{4}$ degrees, has the honor of growing the greatest potato crop on record and of capturing the American Agriculturist first prize of \$250 for the largest yield of potatoes on one measured acre in 1890, also a like prize offered by special act of the Wyoming Legislature to the man who would bring the American Agriculturist grand prize to that enterprising territory.

"The Contest Acre was a rich sandy loam, in its native state bearing a heavy growth of blue-stem grass, naturally dry, and worth about \$20 per acre. The virgin soil was broken up for the first time in the spring of 1888, when it was planted to vegetables, without cultivation. In 1889 it was in garden crops, worked with a cultivator and shovel plow, but no manure of any kind was ever applied to it. It was plowed April 7, 1890, six to eight inches deep, with a Bradley

sulky plow and three horses, taking one man half a day. April 14 it was thoroughly harrowed by the Perfect harrow, drawn by three horses. It was marked out in furrows two and one-half feet apart and six inches deep, made by the sulky plow, the sets being dropped eight inches apart in the row, making 22,800 hills on the acre. The planting was done by one man from May 7 to 14, the ground damp and in good growing condition, but after that there was no more rain. The seed was all dropped and covered by hand. A thin board three inches wide, with three two-inch holes eight inches apart and eight inches from each end being used to drop by. The seed was covered two inches deep with a garden rake. When the potatoes came up, more earth was raked into the trench so as to almost cover the plant. The potatoes were cut with one, two and three eyes to a set, the piece being as large as the potato would admit of; 1,560 pounds of seed were used. About one-half the acre was planted with the Early Vermont variety the rest being Manhattan, Rural New Yorker No. 2, and three of Mr. Sturgis' own seedlings. The largest and best seed was selected from fifty bushels, but fully 3,000 hills did not come up, and were not replanted, as it was so late. In digging Mr. Sturgis found sets that were still sound and had never sprouted, and recommends to cut, plant and cover potatoes the same day, covering as fast as dropped,—as important suggestion in so dry a climate. The seed was all of his own raising.

"Irrigation.—The crop was fairly up June 12 when both soil and air were cool and dry. The single plow was run through the furrows on one-half the acre on June 18, a man with a hoe following and pulling the soil away from any plants that were covered, and pulling and cutting all weeds. Five days later the balance of the acre was gone over in the same way. On July 5 it was plowed out again, and July 7 was hoed and hand-weeded. On this day about one-third of the acre was irrigated, and by July 8 the whole acre had

been thoroughly watered by irrigation. It was irrigated twice a week until July 29, the weather being very dry, with no rain whatever.

"The Harvest.—On August 30 Mr. Sturgis notified the American Agriculturist that he should be ready to harvest his crop in the course of a fortnight or so. He began the work September 17, using a common twelve-inch Moline plow. One row on each side was plowed and the tubers picked up. Then two men with four-tined forks went over and forked out any potatoes that were covered up. Then two more rows were plowed and worked in the same way. About six days were occupied in harvesting, two men digging and three men picking up. The tubers were put in sacks containing 110 to 140 pounds, set in a wagon and hauled to the cellar, where they were weighed, on tested platform scales, as taken from the wagon, and then emptied into the bins in the cellar. An accurate tally was kept of all weighings and of the weight of the sacks. They were no other potatoes planted within eighty rods of the prize acre. Mr. Sturgis says the quality of the potatoes could not be surpassed in any way. They were not scabby, but were smooth, sound, and fine in every respect except from two places on the acre, where the water stood.

"The total yield was 58,488 pounds or 974 bushels and forty-eight pounds. Of these 50,320 pounds, or 838 bushels and forty pounds were merchantable tubers, and 8,168 pounds, or 136 bushels and eight pounds were small and unmerchantable. An average bushel of the larger size contained 102 tubers, and of the unmerchantable there were 462 potatoes in one bushel. The acre was measured May 17, by J. B. Mernardi, a sworn surveyor of Buffalo, in the presence of W. J. Thom and Sydney Sturgis. The harvesting was done in the presence of T. J. Keeser, J. M. Bennett, and Sydney Sturgis, who, with the contestant, William J. S. Sturgis, swore to the truth and accuracy of the harvesting

in every respect before N. L. Andrews, Notary Public and United States Commissioner, of Buffalo. The surveyor's certificate is sworn to before John T. Martin, Notary Public. The dimensions of the acre are 330 by 132 feet, containing just 43,500 square feet.

"The first prize of \$250, offered by the "American Agriculturist" for the largest yield, is therefore, awarded to William J. S. Sturgis, of Buffalo, Wyoming, who is also entitled to \$250 appropriated for this purpose by the Wyoming Legislature. His crop has certainly paid him handsomely. His expenses were as follows: Interest on value of land, \$1.20; plowing, \$2.00; harrowing, \$2.00; furrowing, \$1.00; value of seed, \$15; cultivating, \$5.00; irrigating, \$8.00; harvesting, \$40; total, \$74.80.

"Mr. Sturgis is selling the crop at ninety cents per bushel, or \$754.80 for the 838 2-3 bushels of marketable tubers; the small potatoes at twenty-five cents, are worth \$34, making total receipts of \$788.80. Deducting the expenses, we have \$714 as the net profits on this first prize acre, exclusive of prizes."

PART II.

VARIETY TEST.

There are so many varieties of potatoes commonly grown that the limited number we have investigated can not be called an extensive variety test. Fifty sorts, mostly well-known kinds, were selected in the spring of 1894 and have been grown for three seasons. Not all of these varieties were planted upon each of the sub-stations though at Sheridan a larger number of kinds have been grown. Growing so many varieties has given more trustworthy results in the various experiments and has afforded better opportunity for the study of potatoes under our widely differing conditions. Growing the varieties for three consecutive seasons has enabled us to determine the more valuable kinds and has largely eliminated the effects of variations, which would decrease the value of the data by making it more unreliable if they were only grown a single season. The varieties have been arranged in the tables in the order of their yields, putting those first which yielded the largest crops. In general it may be stated that any of those varieties which stand near the top of the average tables for each farm will give satisfaction in the section of the state represented and can be recommended for general planting. As a rule the early varieties do not yield as large crops as medium or late kinds and this should be kept in mind when studying the tables. The dates that the tubers are ready for market and the condition of the vines at time of frost indicate whether the variety is early or late. It is of interest to note the difference in yield of the same variety in different years. For example

the Bill Nye gave the largest yield in 1895 at Laramie and stands at the top of the table for that year, while in 1896 it is number 29 in the list. On this account the average tables will be of the greatest practical value.

LARAMIE.

Tables XXI and XXII give the varieties grown at Laramie in 1891, 1892, and 1893. The yields of these years are not averaged in with the yields of 1894, 1895 and 1896 in table XXVI. The tables are self-explanatory. The yields given are of marketable potatoes expressed in sacks of 100 pounds each. This was done because in Wyoming farm crops are almost always bought and sold by the hundred pounds. The yields given in sacks may easily be converted into pounds or bushels if desired. Wherever we have used the term bushel in this bulletin a bushel of sixty pounds is meant.

In 1894, the first year the varieties were grown at this altitude, nearly half of them did not come into bloom. Some of them produced buds which were abortive, and fell off without opening. In 1895 only about one-fourth of the varieties failed to blossom and in 1896 about one-eighth of the total number failed to open their buds. In 1896 also many more of the varieties ripened their tubers than in 1895. It would seem that they have been adapting themselves to our conditions and that growing them a number of years in the same place causes potatoes to become acclimated. The varieties were all grown under the same conditions and treated alike. In 1894 and 1895 seed at the rate of 1,000 pounds per acre was used and in 1896 seed at the rate of 700 pounds per acre was used. Each year planting was done between May 9th and 13th. In 1894 the rows were two feet apart and in '95 and '96 two and one-half feet apart.

TABLE XXI.—*Potatoes, Laramie, 1891.*

No.	VARIETY.	Total Yield per acre in sacks of 1 cwt.	Per cent marketable	Yield marketable per acre in sacks of 1 cwt.
1	Early Rose	75.0	91	68.7
2	Beauty of Hebron	68.8	86	59.2
3	Chicago Market	66.8	87	58.1
4	California Rose	59.1	70	41.6
5	Mammoth Prolific	54.0	80	43.2
6	Rose Seedling	54.0(?)	88	47.6(?)
7	White Elephant	48.2	97	46.7
8	Mammoth Pearl	44.3	77	34.8
9	Early Puritan	42.2	78	32.8

TABLE XXII.—*Potatoes, Laramie, 1892 and 1893.*

VARIETY.	Yield per acre in sacks of 1 cwt.		VARIETY.	Yield per acre in sacks of 1 cwt. 1893.
	1892	1893		
Polaris	174	6.7	Beauty of Hebron	6.6
Early Maine	165	12.6	California Rose	8.9
Early Rose	164	10.4	Smooth Blue	31.9
Mogul	157	16.0	Clark's No. 1	35.5
Empire State	150	13.9	Early Puritan	4.1
Pride of America	116	7.0	White	26.0
Early Minnesota	114	20.2	White Elephant	16.6
Early Ohio		33.5	Snow Drop	16.6
Pink		35.6		

TABLE XXIII.—Potatoes, Laramie, 1894.

No.	VARIETY.	In bloom.	Condition of tops at time of frost.	Per cent marketable.	Yield marketable per acre in sacks of 1 cwt.	Weight of largest sds.
1	Chas Downing.	July 17	Ripe	95	313	2.7
2	Monroe's Seedling.	" 17	Green	96	229	2.6
3	Early Northern.	" 10	"	95	219	2.6
4	Burpee's Superior.	" 17	"	95	212	2.6
5	Blue Victor.	" 17	Ripening	96	199	2.6
6	Delaware.	" 17	Green	95	185	2.4
7	Montana Wonder.	" 17	"	96	173	2.4
8	Koshkonong.	" 17	"	94	165	2.3
9	Boston Red.	" 17	Ripening	87	163	2.3
10	Rochester Rose.	" 17	Green	90	161	2.3
11	Manitoba Rose.	" 17	"	88	159	2.2
12	Early Minnesota.	" 17	"	89	155	2.2
13	Rural Blush.	" 17	"	91	155	2.2
14	Late Puritan.	" 17	"	93	154	2.2
15	Bill Nye.	" 10	"	90	146	2.1
16	Arizona.	" 17	"	91	145	2.1
17	Pearl of Savoy.	" 10	"	87	141	2.0
18	Alexander Prolific.	" 10	"	92	140	2.0
19	Rose Seedling.	" 10	Ripening	95	138	2.0
20	Empire State.	" 10	Green	88	136	2.0
21	Morning Star.	" 17	"	91	133	2.0
22	Pride of the West.	" 17	"	95	129	2.0
23	Thornburn.	" 17	Ripe	87	127	2.0
24	World's Fair.	" 17	Green	95	125	2.0
25	Early Rose.	" 17	"	91	124	2.0
26	Snow Drop.	" 17	"	89	123	2.0
27	Early Sunrise.	" 17	"	83	120	2.0
28	Ohio Junior.	" 10	Ripe	93	118	2.0
29	St. Patrick.	" 10	Green	91	115	2.0
30	Brownell's Winner.	" 10	"	84	106	2.0
31	Chicago Market.	" 17	"	80	102	2.0
32	Clark's No. 1.	" 10	"	84	101	2.0
33	White Star.	" 10	"	91	100	2.0
34	Freeman.	" 10	"	78	97	2.0
35	Rural New Yorker.	" 17	Ripening	91	95	2.0
36	Vanguard.	" 17	Ripe	82	89	1.5
37	Burpee's Extra Early.	" 17	"	90	87	2.3
38	Mammoth Pearl.	" 17	Green	93	79	4.1
39	Early Six Weeks.	" 17	Ripe	91	74	1.7
40	Polaris.	" 17	"	91	72	2.2
41	Reed's No. 86.	" 17	"	77	66	1.7
42	Albino.	" 17	"	84	60	1.5
43	Acme Seedling.	" 17	"	88	45	2.2
44	Summit.	" 17	Green	61	37	3.0
45	Ohio Red.	" 17	Ripe	48	36	2.9
46	Dakota Red.	" 17	Green	50	26	2.1
47	Early Ohio.	" 17	Ripe	51	18	2.0
48	New Queen.	" 17	Ripening	61	17	1.3
49	White Elephant.	" 17	"	38	11	1.3
50						3.3

TABLE XXIV.—Potatoes, Laramie, 1895.

No.	VARIETY.	Date of first bloom.	Length of vines when first in bloom.	Condition of vines at time of frost.	Per cent of total yield marketable.	Yield per acre marketable, in sacks of 1 cwt.	Weight of largest twelve.	Maturity of tubers.
			<i>inches</i>				<i>lbs.</i>	
1	Bill Nye	July 27	13	Green	87.2	143.8	7.12	Not ripe
2	Rural Blush	" 22	12	"	89.1	124.7	5.77	"
3	Morning Star	" 27	15	"	85.1	124.3	7.12	"
4	Pride of the West	" 29	15	"	91.7	124.0	7.0	"
5	Koshkonong	Aug. 9	14	"	90.7	117.5	9.2	"
6	Chas. Downing	July 30	16	"	86.3	117.3	6.0	"
7	Alexander Prolific	" 25	12	"	89.2	115.6	6.12	"
8	Delaware	" 23	12	"	87.9	115.0	7.6	"
9	Blue Victor	" 19*	11*	"	89.1	113.1	8.5	"
10	Manitoba Rose	" 27	14	"	85.9	112.2	7.0	"
11	Late Puritan	" 31	14	"	84.9	110.2	6.2	"
12	Clark's No. 1	" 29	13	Ripening	74.9	107.6	5.1	Ripe
13	Pearl of Savoy	" 31	13	Green	91.1	104.7	6.9	"
14	Early Sunrise	" 31	13	"	83.3	106.6	6.7	"
15	Burpee's Superior	" 30	15	"	88.0	105.2	5.5	"
16	Brownell's Winner	" 30	14	"	84.2	104.6	6.5	Not ripe
17	White Star	" 27	12	"	89.7	103.6	4.9	Ripe
18	Boston Red	" 19*	12*	"	89.3	102.4	5.2	Not ripe
19	St. Patrick	Aug. 3	14	"	88.4	100.1	6.0	"
20	Montana Wonder	July 31	14	"	91.0	98.1	6.3	"
21	Arizona	" 29	12	"	82.7	97.7	5.9	Ripe
22	Monroe's Seedling	Aug. 9	12	"	86.3	97.6	4.9	Not ripe
23	Early Northern	" 9	12	"	85.2	96.1	5.8	Ripe
24	Early Rose	July 31	13	"	87.1	94.5	6.3	Not ripe
25	Mammoth Pearl	Aug. 12	12	"	87.4	89.7	8.12	"
26	Chicago Market	July 23	11	"	87.4	88.3	6.9	"
27	Acme Seedling	" 16*	12*	Ripe	86.4	87.8	4.7	Ripe
28	Summit	" 31	13	Green	85.0	86.0	5.5	"
29	Early Minnesota	" 16*	10*	Ripe	77.1	80.8	4.8	Not ripe
30	World's Fair	Aug. 12	12	Green	87.8	80.8	4.8	Ripe
31	Burpee's Extra Early	" 3	15	"	78.2	80.4	5.2	"
32	Rochester Rose	" 3	14	"	84.8	79.5	5.8	Not ripe
33	Empire State	" 5	15	"	82.8	78.1	7.5	"
34	Rose Seedling	July 22	12	"	89.8	74.4	7.1	Ripe
35	Dakota Red	Aug. 20	15	"	63.6	74.2	4.8	Not ripe
36	Vanguard	July 31	12	Ripe	84.2	72.7	4.2	"
37	White Elephant	Aug. 12	13	Green	81.8	72.1	3.6	"
38	Albino	July 22*	11*	"	68.1	70.5	3.8	Ripe
39	Snow Drop	Aug. 3	14	"	75.0	69.4	6.0	Not ripe
40	Reed's No. 86	July 31†	13†	Ripe	77.8	67.9	3.7	Ripe
41	New Queen	" 30†	11†	Green	71.9	67.1	3.8	Not ripe
42	Ohio Junior	" 21*	11*	Ripe	87.8	65.6	4.7	"
43	Early Six Weeks	Aug. 5†	11†	"	79.4	64.6	4.1	"
44	Ohio Red	July 22*	12*	"	83.6	62.4	4.5	"
45	Early Market	Aug. 5†	11†	"	80.7	56.9	4.5	"
46	Thornburn	July 25	11	Ripening	82.2	54.7	4.2	Ripe
47	Early Ohio	Aug. 12	12	Ripe	81.6	51.1	3.8	Not ripe
48	Freeman	July 25	11*	Green	65.7	47.2	3.8	"
49	Polaris	Aug. 12	12	Ripening	73.6	45.9	3.0	"
50	Rural New Yorker	" 9	14	Green	85.7	45.5	4.2	"

*Date of first bud and length of vine on same day.

†Buds abortive, and date when length of vine was taken.

‡No buds.

TABLE XXV.—Potatoes, Laramie, 1896.

No.	VARIETY.	Date of first bloom.	Length of vines when first in bloom.	Condition of vines at time of frost.	Per cent of total yield marketable.	Yield per acre marketable, in sacks of 1 cwt.	Weight of largest twelve.	Maturity of tubers.
			<i>inches</i>				<i>lbs.</i>	
1	Alexander Prolific . . .	July 18	14	Green	88.7	164.2	8.0	Ripe
2	Deleware . . .	" 17	15	"	91.2	159.4	8.5	"
3	Morning Star . . .	" 17	16	"	91.8	147.3	10.0	"
4	Burpee's Superior . . .	" 25	15	"	85.8	132.4	6.2	"
5	Mammoth Pearl . . .	Aug. 4	16	"	91.5	128.8	9.0	"
6	Chas. Downing . . .	July 25	14	"	89.2	125.2	6.6	"
7	St. Patrick . . .	" 17	13	"	93.4	124.7	10.0	"
8	Manitoba Rose . . .	" 28	18	"	89.0	124.5	7.1	"
9	Pearl of Savoy . . .	" 20	13	"	93.7	122.0	9.8	"
10	Boston Red . . .	Aug. 4	16	"	86.5	118.6	7.6	"
11	Blue Victor . . .	" 1	14	"	91.8	116.7	9.5	"
12	Clark's No. 1 . . .	July 17	15	"	87.1	116.5	8.1	"
13	Empire State . . .	" 25	14	"	92.3	115.2	7.5	"
14	Summit . . .	" 20	12	"	92.2	113.9	7.6	"
15	Early Northern . . .	" 20	15	"	90.6	109.8	8.7	Not ripe
16	Arizona . . .	" 25	12	"	91.6	108.3	7.7	Ripe
17	Early Sunrise . . .	" 17	13	"	89.8	107.6	8.0	"
18	Burpee's Extra Early . . .	" 20	14	"	89.1	102.1	7.0	"
19	White Elephant . . .	" 25	16	"	84.7	101.6	5.3	"
20	Reed's No. 86 . . .	" 20	14	"	90.9	100.8	9.0	"
21	Koshkonong . . .	" 25	15	"	92.3	100.0	10.5	"
22	Albino . . .	" 17	12	Ripe	90.8	99.0	6.5	"
23	Early Rose . . .	" 18	14	Green	86.0	95.7	7.0	"
24	Freeman . . .	" 12*	12*	"	76.3	94.4	5.9	"
25	Snow Drop . . .	" 25	15	"	82.2	94.1	7.1	"
26	Montana Wonder . . .	" 25	13	"	86.1	91.6	9.7	"
27	New Queen . . .	" 20	13	"	86.7	90.7	6.3	"
28	Brownell's Winner . . .	" 28	15	"	92.5	89.1	7.7	"
29	Bill Nye . . .	" 25	14	"	86.4	89.0	8.9	"
30	White Star . . .	" 24	16	"	82.8	82.3	6.5	"
31	Chicago Market . . .	" 18	15	"	94.4	87.7	8.8	" (?)
32	Early Minnesota . . .	" 25	12	Ripe	87.8	83.0	6.2	"
33	Thornburn . . .	" 20	14	"	85.9	82.7	7.1	"
34	Early Market . . .	" 12*	12*	"	93.9	79.4	7.0	"
35	Early Six Weeks . . .	" 24	12	"	92.6	78.9	6.2	"
36	Ohio Junior . . .	" 13*	13*	"	95.9	78.4	6.5	"
37	Rochester Rose . . .	" 24	12	Green	95.3	76.4	8.0	"
38	Polaris . . .	" 20	13	"	85.3	73.7	"	"
39	Rural New Yorker . . .	" 28	15	"	87.9	68.9	6.0	"
40	Acme Seedling . . .	" 12*	12*	"	91.4	68.8	6.6	"
41	Rural Blush . . .	" 17	16	"	81.8	67.8	4.2	"
42	Late Puritan . . .	" 27	13	"	89.1	66.9	8.0	Not ripe
43	World's Fair . . .	" 28	14	"	86.8	66.2	5.5	"
44	Early Ohio . . .	" 12*	12*	Ripe	91.2	62.5	6.0	Ripe
45	Monroe's Seedling . . .	" 28	15	Green	87.4	61.4	6.7	"
46	Rose Seedling . . .	" 24	14	Ripe	94.8	58.7	7.2	"
47	Pride of the West . . .	" 28	12	Green	89.5	58.5	6.3	"
48	Dakota Red . . .	Aug. 4	16	"	71.8	52.5	4.5	Not ripe
49	Ohio Red . . .	" 10*	10*	"	87.3	30.3	6.5	"
50	Vanguard . . .	July 25	16	"	88.7	22.2	4.5	Ripe

*Did not come into bloom. Length of vine taken Aug. 11.

TABLE XXVI.—Potatoes, Laramie. Average of three years' crops.

No.	VARIETY.	Average yield per acre marketable, in sacks of 1 cwt.	Average per cent marketable.	Average weight of largest twelve.
1	Chas. Downing	185.3	89.8	5.0
2	Delaware	153.1	91.4	6.1
3	Burpee's Superior	150.0	92.9	6.2
4	Blue Victor	142.8	90.5	5.2
5	Early Northern	141.8	90.2	5.6
6	Morning Star	134.7	90.0	7.6
7	Manitoba Rose	132.0	87.8	6.5
8	Alexander Prolific	129.9	85.8	7.7
9	Monroe's Seedling	129.2	89.6	6.3
10	Boston Red	127.9	87.6	5.8
11	Koshkonong	127.5	92.3	9.1
12	Bill Nye	126.1	87.8	7.4
13	Pearl of Savoy	123.2	90.6	7.3
14	Montana Wonder	120.9	94.4	8.8
15	Arizona	117.1	88.3	6.7
16	Rural Blush	115.7	87.1	5.6
17	St. Patrick	113.4	90.9	7.7
18	Early Sunrise	111.4	85.2	6.4
19	Late Puritan	110.4	86.9	7.7
20	Empire State	109.7	87.7	6.5
21	Clark's No. 1	108.5	83.3	5.6
22	Early Minnesota	105.2	84.7	5.3
23	Rochester Rose	105.8	90.1	6.2
24	Early Rose	104.7	92.3	6.8
25	Early of the West	104.0	92.0	6.3
26	Brownell's Winner	99.8	86.9	6.2
27	Mammoth Pearl	99.1	90.5	8.4
28	White Star	97.5	89.7	5.8
29	Snow Drop	95.6	92.1	6.3
30	Chicago Market	92.5	87.3	7.9
31	World's Fair	90.5	89.8	5.4
32	Rose Seedling	90.4	93.2	6.9
33	Burpee's Extra Early	89.9	85.7	5.7
34	Thornburn	88.1	85.1	5.2
35	Ohio Junior	83.9	92.1	5.5
36	Freeman	79.6	75.3	4.7
37	Summit	78.5	75.3	6.3
38	Reed's No. 86	76.3	82.2	5.3
39	Early Six Weeks	72.4	87.3	4.5
40	Albine	71.5	82.4	4.9
41	Rural New Yorker	69.7	82.2	5.6
42	Acme Market	69.3	79.8	5.4
43	Acme Seedling	64.5	79.8	5.8
44	Polaris	61.7	78.6	3.9
45	Vanguard	61.3	84.9	4.2
46	New Queen	56.5	85.7	4.1
47	Dakota Red	48.4	82.3	4.4
48	Early Ohio	43.5	76.1	4.1
49	Ohio Red	42.6	73.6	5.0
50	White Elephant	36.8†	83.2†	4.1†

*Average for two years.

†Average for two years. In 1904 the total yield of White Elephant was 168.4 sacks. The per cent marketable was not taken. Assuming the per cent marketable to be 80, which is below its average, this would place this variety No. 26 in the list.

Section of Potato Plat

Dame
Seedling

Albino

Wendell
Polish

Arizona

Bill Nye

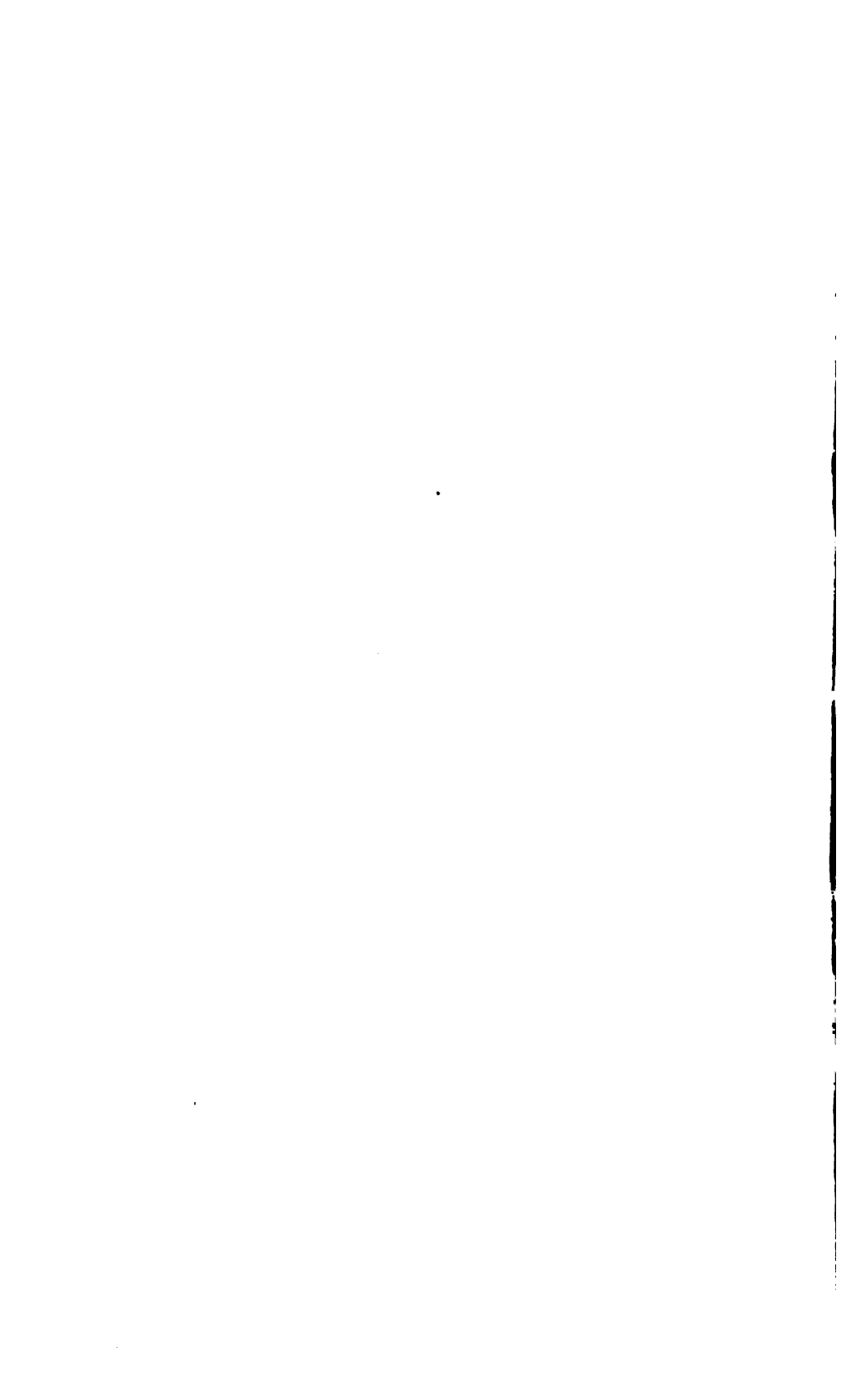
Blue
Victor

Boston
Red

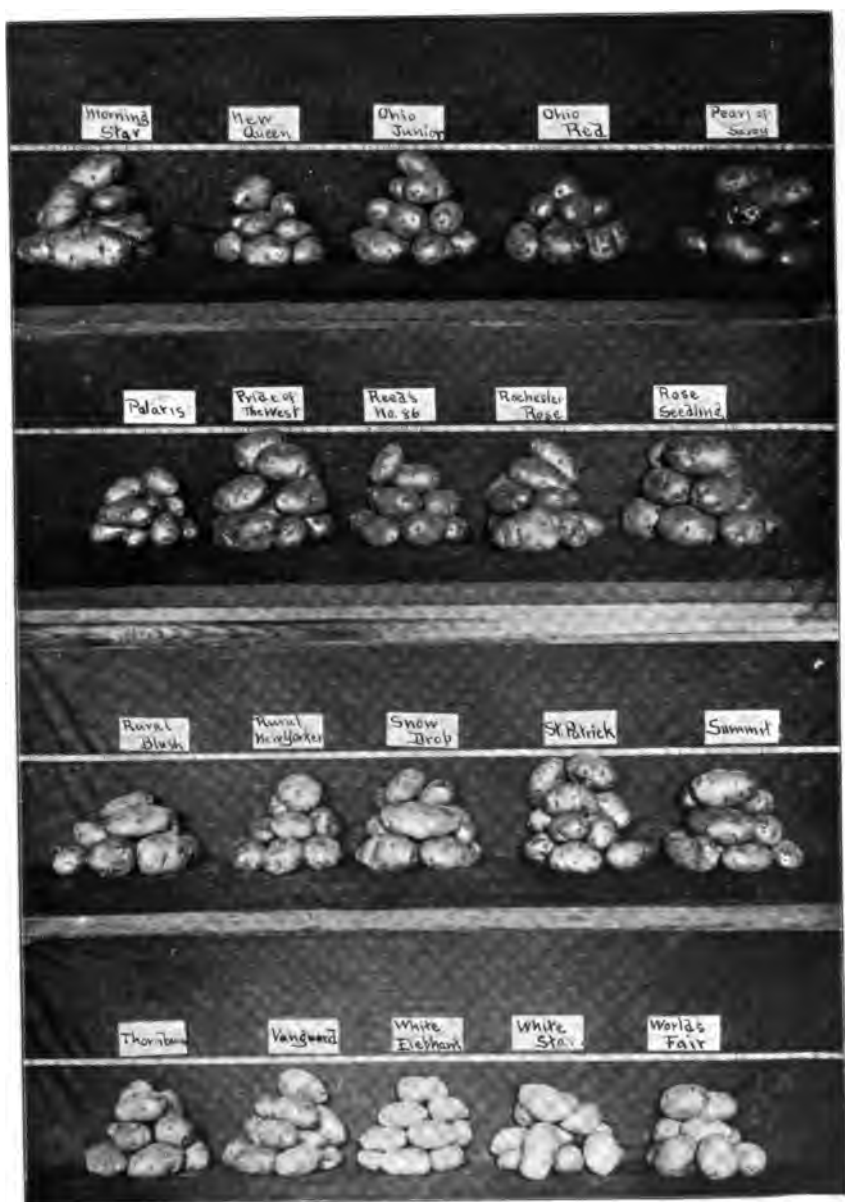
Braniff
Winn

Barber's
Extra Early

Barber's
Superior







LANDER.

Tables XXVII to XXXI inclusive give the results with the varieties grown for four years. In 1893 the yields given are averages from two different plats. (See potatoes on different soils at Lander, page 6.) The rows were three and one-half feet apart and the seed was dropped twelve inches apart in the rows, the seed was cut leaving from one to four eyes to each piece and planted at the rate of from 300 pounds to 400 pounds per acre. They were irrigated four times. On August 29th a heavy rain fell which kept the ground so wet that the potatoes did not fully ripen. The largest twelve tubers from the twelve varieties weighed eighteen pounds.

In 1894 the potatoes were planted May 4th and 5th at rates of from 364 to 572 pounds per acre. The crop was injured somewhat by the "Utah Crickett."

In 1895 the potatoes were cut two eyes to the piece and were planted at the rate of from 500 pounds to 600 pounds per acre.

In 1896 twenty of the varieties were grown from seed sent from the Laramie farm. Only a small amount of each variety was grown, hardly enough to warrant the computing of yields per acre. The varieties grown from Laramie seed produced larger average yields than those from home grown seed. Those kinds of which seed was furnished from Laramie are indicated in the table by asterisks. Table XXXI gives the averages of all those varieties which were grown for four years.

TABLE XXVII.—*Lander, 1893.*

No.	VARIETY.	Yield in sacks of 1 cwt. each.	No.	VARIETY.	Yield in sacks of 1 cwt. each.
1.	Late Puritan	228.0	7	Beauty of Hebron	186.6
2.	Early Puritan	225.2	8	Pride of the West	141.5
3.	Early Mayflower	219.5	9	Early Rose	133.1
4.	Snow Drop	200.3	10	Jumbo	130.4
5.	White Elephant	199.0	11	Bill Nye	129.2
6.	Empire State	190.3	12	Vanguard	65.4

TABLE XXVIII.—*Lander, 1894.*

No.	VARIETY.	Date ripe.	Ma- tured in days.	Yield per acre in sacks of 1 cwt. each.	Weight of largest twelve.
1.	Early Mayflower	Oct. 8	150	144.5	7.5
2.	White Elephant	Oct. 8	150	119.0	11.0
3.	Bill Nye	Oct. 8	150	106.8	7.5
4.	Beauty of Hebron	Oct. 8	150	98.0	8.5
5.	Empire State	Oct. 8	150	93.3	8.0
6.	Jumbo	Oct. 8	150	92.7	10.0
7.	Early Rose	Aug. 3	91	76.6	7.5
8.	Early Puritan	Aug. 15	103	73.5	7.5
9.	Late Puritan	Oct. 8	150	73.2	8.0
10.	Triumph	Oct. 8	150	69.5	8.5
11.	Snow Drop	Oct. 8	150	69.0	7.5
12.	Vanguard	Oct. 8	150	33.5	7.5

TABLE XXIX.—*Lander, 1895.*

No.	VARIETY.	Date in bloom.	Date ready for market.	Ma- tured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
1.	Late Puritan	July 11	July 21	144	198.1	25.0
2.	White Elephant	" 11	" 20	145	186.3	22.0
3.	Triumph	" 16	Aug. 8	144	134.7	14.0
4.	Vanguard	" 11	July 20	145	132.1	17.0
5.	Early Rose	" 11	" 15	111	112.0	14.0
6.	Early Puritan	" 11	" 20	116	110.3	16.8
7.	Empire State	" 16	Aug. 12	144	108.5	9.0
8.	Bill Nye	" 16	" 15	144	86.0	11.0
9.	Early Mayflower	" 11	" 1	144	79.8	9.0
10.	Jumbo	" 16	" 14	144	63.9	15.0
11.	Beauty of Hebron	" 11	" 7	144	53.5	8.5
12.	Pride of the West	" 31	" 5	144	43.3	10.5

TABLE XXX.—*Lander, 1896.*

No.	VARIETY.	Date tubers set.	Length of vines when mature.	Ready for market.	Per cent market- able.	Yield marketable tubers in sacks of 1 cwt. each.	Weight of largest twelve.
			<i>inches</i>				<i>lbs.</i>
1.	Mammoth Pearl*	June 23	34	Aug. 15	95.7	528	9.4
2.	New Queen*	" 23	30	" 1	97.7	434	12.4
3.	Arizona*	" 24	38	" 15	94.6	390	13.4
4.	Brownell's Winner*	July 1	50	" 15	98.1	367	13.2
5.	Early Minnesota*	June 23	30	July 15	97.1	359	10.7
6.	Delaware*	July 1	48	Aug. 15	96.4	354	12.4
7.	Koshkonong*	" 1	31	" 5	94.2	351	10.6
8.	Dakota Red*	" 5	25	" 15	97.2	331	8.5
9.	Blue Victor*	" 1	25	" 15	92.8	303	8.7
10.	Albino*	June 30	38	" 5	96.1	252	8.5
11.	Early Puritan	" 25	28	July 18		245	15.5
12.	Triumph	July 1	29	" 12		233	14.5
13.	Early Market*	June 23	26	" 15	95.7	230	8.8
14.	Early Mayflower	July 1	37	Aug. 5		222	11.5
15.	Manitoba Rose*	June 23	26	July 25	92.2	219	11.1
16.	Boston Red*	July 1	26	Aug. 15	98.8	218	8.6
17.	White Elephant	" 1	38	July 25		213	12.0
18.	Ohio Red*	June 24	28	Aug. 5	96.7	210	8.8
19.	Early Northern*	July 1	22	" 15	86.3	205	8.0
20.	Early Rose	June 25	30	July 10		195	10.0
21.	Early Six Weeks*	" 22	24	" 6	98.4	187	12.0
22.	Jumbo	July 1	34	" 12		187	14.0
23.	Alexander Prolific*	June 28	30	Aug. 15	91.2	186	6.5
24.	Late Puritan	July 1	34	" 1		185	13.0
25.	Bill Nye	" 1	33	" 10		184	8.5
26.	Chicago Market*	June 22	28	" 5	96.2	178	8.4
27.	Acme Seedling*	" 24	24	" 5	97.2	170	7.2
28.	Chas Downing*	July 1	23	" 5	85.6	163	4.6
29.	Beauty of Hebron	" 1	30	" 8		153	10.0
30.	Snow Drop	" 1	32	" 12		152	7.0
31.	Pride of the West	" 8	29	" 1		146	8.5
32.	Vanguard	" 1	27	July 25		125	8.0

*Seed grown upon Laramie Farm, 1895.

TABLE XXXI.—*Average for Lander.*

No.	VARIETY.	Average yield for 4 years in sacks of 1 cwt. each.	Average weight for 3 yrs. of largest twelve.
			<i>lbs.</i>
1.	White Elephant	179.3	15.0
2.	Late Puritan	171.1	15.3
3.	Early Mayflower	168.2	9.3
4.	Early Puritan	163.7	13.3
5.	Triumph	145.7	12.3
6.	Snow Drop*	137.1	7.3
7.	Empire State*	130.7	8.5
8.	Early Rose	129.2	10.5
9.	Bill Nye	126.5	9.0
10.	Jumbo	118.5	13.0
11.	Beauty of Hebron	117.8	9.0
12.	Pride of the West*	110.3	9.5
13.	Vanguard	89.0	10.8

*Average taken for two years.

SARATOGA.

Tables XXXII and XXXIII gives the results from the varieties grown upon the Saratoga farm in 1893 and 1894.

In 1893 they were planted May 16th and harvested September 28th.

In 1894 planting was done May 22d and harvesting September 28th, 480 pounds seed per acre being used. Since 1894 on account of lack of water the Saratoga farm has not been operated, and we have not averaged the results for the two years.

TABLE XXXII.—*Saratoga, 1893.*

No.	VARIETY.	Date in bloom.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
1.	Blue Victor	July 28	188.1	8.0
2.	Late Rose	" 24	184.8	10.0
3.	Early Mayflower	" 7	176.7	6.0
4.	Late Puritan	" 25	157.8	8.0
5.	White Elephant	" 23	147.2	
6.	Clark's No. 1	" 21	146.2	
7.	Snow Drop	" 24	143.0	4.0
8.	White Russett	" 27	131.6	
9.	Early Sunrise	" 24	132.3	
10.	Early Rose	" 20	122.4	
11.	Vanguard	" 25	120.4	
12.	Early Ohio	" 22	118.8	
13.	Pride of the West	" 26	118.8	5.0
14.	Beauty of Hebron	" 21	108.0	
15.	Empire State	" 27	107.5	
16.	Triumph	" 28	99.0	
17.	Chas. Downing	" 25	89.0	

TABLE XXXIII.—*Saratoga, 1894.*

No.	VARIETY.	Date in bloom.	Date ripe.	Ma- tured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
1.	Morton White	Aug 1	Sept 23	105	251.4	13.5
2.	Triumph	July 23	" 23	105	230.8	12.0
3.	Clark's No. 1	" 23	" 10	92	217.8	14.0
4.	Eager's No. 1	" 23	" 10	92	189.0	12.0
5.	Early Ohio	" 20	" 10	92	180.0	9.0
6.	Snow Drop	" 20	" 10	92	166.8	12.0

SHERIDAN.

In 1894 the potatoes were planted May 11th. No other notes were furnished except the yield for each variety as given in table XXXIV.

In 1895 they were planted April 26th in rows forty-two inches apart and hills twenty-four inches apart in the rows.

In 1896 they were planted May 7th at the rate of 700 pounds per acre. For complete data consult the tables XXXIV to XXXVII inclusive.

TABLE XXXIV.—*Sheridan, 1894.*

No.	VARIETY.	Yield in sacks of 1 cwt. each.	No.	VARIETY.	Yield in sacks of 1 cwt. each.
1.	Dakota Red.....	200	29	Iron Clad.....	151
2.	Rose Seedling.....	193	30	Chicago Market.....	151
3.	Ohio Red.....	191	31	Rural Blush.....	149
4.	Snow Drop.....	191	32	New Queen.....	147
5.	Delaware.....	188	33	Thornburn.....	145
6.	Summit.....	188	34	World's Fair.....	145
7.	Rochester Rose.....	186	35	Blue Victor.....	143
8.	White Star.....	186	36	Ohio Junior.....	143
9.	Arizona.....	181	37	Maule's Freeman.....	142
10.	Chas. Downing.....	174	38	Morning Star.....	142
11.	Koshkonong.....	174	39	St. Patrick.....	142
12.	Boston Red.....	171	40	Montana Wonder.....	136
13.	Early Market.....	170	41	Rural New Yorker.....	136
14.	Reed's No. 86.....	170	42	Early Rose.....	135
15.	Acme Seedling.....	168	43	Early Norther.....	132
16.	Monroe's Seedling.....	168	44	Manitoba Rose.....	129
17.	Brownell's Winner.....	165	45	Bill Nye.....	129
18.	Burpee's Extra Early.....	165	46	Early Minnesota.....	126
19.	Alexander Prolific.....	159	47	Early Ohio.....	125
20.	Mammoth Pearl.....	159	48	Albino.....	122
21.	Beauty of Hebron.....	159	49	Vanguard.....	121
22.	Colorado Red.....	157	50	Early Six Weeks.....	116
23.	Empire State.....	157	51	Pearl of Savoy.....	116
24.	Clark's No. J.....	156	52	White Elephant.....	115
25.	Marquet.....	153	53	Polaris.....	101
26.	Burpee's Superior.....	153	54	Pride of the West.....	90
27.	Early Sunrise.....	153	55	Snow Drop No. 1.....	92
28.	Hotel Favorite.....	153			

TABLE XXXV.—*Sheridan, 1895.*

N.o.	VARIETY.	Date in bloom.	Date ripe.	Ma- tured in days.	Yield per acre in sacks of 1 cwt. each.	Weight of largest twelve. <i>lbs.</i>
1.	Bill Nye	July 30	Sept. 7	103	196	10
2.	Arizona	" 30	Aug. 25	101	195	11
3.	St. Patrick	" 28	Sept. 16	119	192	12
4.	Hotel Favorite	" 30	" 6	111	186	11
5.	Early Market	" 30	Aug. 26	108	184	10
6.	Empire State	" 30	Sept. 16	124	177	11
7.	Chicago Market	" 30	" 9	117	161	8
8.	Rural Blush	" 25	" 16	122	160	8
9.	Morning Star	" 25	" 5	109	157	10
10.	Clark's No. 1	" 28	Aug. 26	107	155	6
11.	Delaware	" 30	Sept. 10	122	154	9
12.	Montana Wonder	" 30	" 19	124	154	8
13.	Rochester Rose	None	Aug. 30	102	153	8
14.	Marquette	July 28	" 20	97	152	8
15.	Mammoth Pearl	None	Sept. 12	110	151	10
16.	Late Puritan	July 28	" 19	122	149	8
17.	New Queen	" 28	Aug. 23	103	148	7
18.	White Elephant	" 28	Sept. 7	115	148	7
19.	Thornburn	" 28	Aug. 27	104	147	8
20.	Chas. Dawning	" 28	" 20	97	146	8
21.	Dakota Red	" 30	Sept. 19	126	141	11
22.	White Star	" 29	" 4	112	140	10
23.	Rose Seedling	" 30	Aug. 28	105	140	6.5
24.	Pride of the West	" 30	Sept. 6	110	135	8
25.	Monroe's Seedling	None	" 12	119	134	8
26.	Brownell's Winner	July 30	" 10	118	131	4
27.	Rochester Rose	None	Aug. 28	100	130	7
28.	World's Fair	" 28	" 28	101	130	6
29.	Iron Clad	July 25	Sept. 10	113	128	8
30.	Burpee's Superior	" 29	" 16	120	126	7
31.	Beauty of Hebron	" 28	Aug. 20	96	125	7
32.	Vanguard	" 20	" 28	107	124	6
33.	Pearl of Savoy	None	" 25	104	122	8
34.	Polaris	July 25	" 18	97	122	6
35.	Summit	" 30	" 28	102	122	8
36.	Burpee's Extra Early	None	" 15	93	120	6
37.	Manitoba Rose	July 28	" 27	106	120	7
38.	Rose Seedling	" 20	" 28	110	119	7
39.	Early Northern	None	" 27	104	118	8
40.	Koshkonong	" 27	Sept. 10	123	117	10
41.	Rural New Yorker	July 20	" 16	124	117	10
42.	Ohio Junior	None	Aug. 27	104	114	6
43.	Early Minnesota	July 30	" 22	102	110	7
44.	Reed's No. 86	None	" 27	109	107	9
45.	Colorado Red	" 27	" 27	103	99	7
46.	Early Sunrise	July 25	" 28	109	99	6
47.	Boston Red	" 28	Sept. 6	113	98	6
48.	Snow Drop	" 30	Aug. 28	105	91	5
49.	Blue Victor	None	" 27	101	90	9
50.	Albino	" 30	" 30	110	87	6
51.	Acme Seedling	July 25	" 27	104	83	6
52.	Alexander Prolific	" 26	" 26	102	82	4
53.	Maule's Freeman	None	" 20	100	82	8
54.	Early Six Weeks	" 22	" 22	103	79	6
55.	Early Ohio	July 28	" 17	99	77	6
56.	Ohio Red	" 28	" 28	107	69	5

TABLE XXXVI.—*Sheridan, 1896.*

No.	VARIETY.	In bloom.	Length of vines at maturity.	Date ripe.	Matured in days.	Per cent marketable.	Yield in sacks of 1 cwt.	Weight of largest twelve.
			<i>inches</i>					<i>lbs.</i>
1	Chicago Market	July 7	24	Sept. 19	109	87.7	129	5
2	Delaware	June 30	30	" 19	110	83.8	121	8
3	Monroe's Seedling	July 8	23	Aug. 30	90	81.8	121	6
4	Early Market	June 30	25	Sept. 19	111	84.4	117	7
5	Pearl of Savoy	" 30	18	Aug. 20	86	67.4	109	5
6	St. Patrick	July 15	17	Sept. 5	105	74.2	109	5
7	White Elephant	" 7	28	" 19	112	85.2	107	5
8	Burbank's Seedling	" 15	36	" 19	111	64.4	106	6
9	Mammoth Pearl	" 9	28	" 19	109	88.4	105	7
10	Burpee's Superior	" 8	20	" 19	110	70.6	104	7
11	Reed's No. 86	" 20	16	Aug. 30	94	85.3	100	6
12	Blue Victor	None	18	" 25	84	72.5	98	5
13	Iron Clad	July 7	16	Sept. 19	110	83.7	98	4
14	Late Puritan	June 30	16	" 20	112	67.0	95	5
15	Beauty of Hebron	" 30	20	" 20	116	87.0	94	5
16	Hepp's White	July 9	25	" 15	109	62.7	91	5
17	Alexander Prolific	" 10	23	Aug. 30	92	90.5	90	7
18	Vanguard	June 30	24	Sept. 30	127	75.6	90	5
19	Brownell's Winner	July 9	26	" 19	112	68.5	89	5
20	Marquett	" 6	20	Aug. 30	95	79.4	89	6
21	Bill Nye	" 9	25	Sept. 19	111	69.4	88	5
22	Chas. Downing	June 30	18	Aug. 30	91	84.7	88	5
23	Colorado Red	July 8	20	Sept. 20	112	70.8	88	5
24	Hotel Favorite	June 30	20	" 15	111	70.2	88	6
25	Clark's No. 1	" 30	18	Aug. 25	90	80.3	87	5
26	Albino	None	18	Sept. 10	101	77.1	85	6
27	Manitoba Rose	July 9	20	Aug. 20	89	82.8	85	6
28	Empire State	" 8	24	Sept. 15	104	57.2	83	4
29	White Star	" 7	28	Aug. 25	87	70.6	83	6
30	Summit	" 6	24	" 28	92	71.2	82	5
31	Rochester Rose	" 7	18	" 28	90	68.2	81	6
32	New Queen	June 30	20	" 25	90	80.3	79	5
33	Snow Drop	July 9	25	" 25	89	61.5	79	5
34	Arizona	June 30	28	Sept. 1	96	79.3	78	6
35	Early Minnesota	" 30	16	Aug. 27	83	70.3	78	5
36	Early Sunrise	July 8	16	Sept. 1	91	79.7	78	6
37	Koshkonong	" 8	16	" 15	105	70.3	78	4
38	Rural New Yorker	" 8	16	" 1	90	81.3	78	4
39	Morning Star	" 9	18	Aug. 15	76	81.0	77	6
40	Boston Red	June 30	18	" 10	72	67.8	72	3
41	Burpee's Extra Early	" 30	16	Sept. 10	107	89.6	72	7
42	Polaris	July 7	15	" 20	110	79.7	72	7
43	Rose Seedling	June 30	18	Aug. 25	84	81.4	72	5
44	Acme Seedling	July 9	18	" 15	77	87.7	69	7
45	Montana Wonder	" 15	20	Sept. 10	104	84.2	69	7
46	Ohio Junior	June 30	18	Aug. 17	78	78.0	66	4
47	Early Rose	July 8	28	" 30	89	77.1	65	5.5
48	Early Northern	June 30	26	" 30	90	74.0	62	5
49	Worlds Fair	July 9	30	Sept. 19	111	68.0	61	4
50	Thornburn	" 9	13	Aug. 30	90	81.8	54	6
51	Rural Blush	June 30	26	" 15	74	69.8	53	5
52	Early Ohio	July 1	18	" 21	87	83.7	52	7
53	Pride of the West	" 7	25	" 30	91	74.4	52	4
54	Ohio Red	None	12	" 25	83	82.0	48	5
55	Dakota Red	" 28	28	Sept. 19	109	67.6	41	3
56	Early Six Weeks	June 30	14	Aug. 25	90	78.8	38	4

TABLE XXXVII.—*Sheridan. Average yields for three years.*

No.	VARIETY.	Average yield for three years in sacks of 1 cwt. each.	Average weight for two years of largest twelve.
			<i>lbs.</i>
1.	Early Market.	157.0	8.5
2.	Delaware	154.0	8.5
3.	Arizona	151.0	8.5
4.	St. Patrick	147.6	8.5
5.	Chicago Market	147.0	8.5
6.	Hotel Favorite	143.0	8.5
7.	Monroe's Seedling	141.0	7.0
8.	Empire State	139.0	7.5
9.	Mammoth Pearl	138.0	9.0
10.	Bill Nye	137.6	7.5
11.	Rochester Rose	137.5	6.0
12.	Rose Seedling	137.0	5.8
13.	White Star	136.0	8.0
14.	Chas. Downing	136.0	6.5
15.	Clark's No. 1	133.0	5.5
16.	Marquet	132	7.0
17.	Summit	131	6.5
18.	Burpee's Superior	129	7.0
19.	Brownell's Winner	128	6.5
20.	Dakota Red	127	7.0
21.	Reed's No. 86	126	7.5
22.	Morning Star	125	8.0
23.	White Elephant	125	6.0
24.	New Queen	125	6.0
25.	Iron Clad	125	6.0
26.	Beauty of Hebron	123	6.0
27.	Late Puritan*	122	6.5
28.	Rural Blush	121	6.5
29.	Montana Wonder	120	7.5
30.	Koshkonong	120	7.0
31.	Burpee's Extra Early	119	6.5
32.	Pearl of Savoy	116	6.5
33.	Thornburn	115	6.5
34.	Colorado Red	115	6.0
35.	Boston Red	114	4.5
36.	Vanguard	112	5.5
37.	World's Fair	112	5.0
38.	Manitoba Rose	111	6.5
39.	Early Sunrise	111	6.0
40.	Rural New Yorker	110	7.0
41.	Blue Victor	110	7.0
42.	Alexander Prolific	110	5.5
43.	Ohio Junior	108	5.0
44.	Acme Seedling	107	6.5
45.	Early Minnesota	105	6.0
46.	Early Norther	105	6.5
47.	Snow Drop	107	5.0
48.	Ohio Red	101	5.0
49.	Polaris	98	6.5
50.	Albino	98	6.0
51.	Pride of the West	95	6.0
52.	Early Ohio	81	6.5
53.	Early Six Weeks	78	5.0

*An average for two years only.

SUNDANCE.

The varieties of potatoes given in Table XXXVIII were planted April 16th, 1893, at the rate of 600 pounds seed per acre.

Table XXXIX gives the results obtained with the different varieties in 1895. They were planted May 14th at the rate of 560 pounds seed per acre.

In 1896 the varieties were planted on land sub-soiled and also on land not sub-soiled and the average for each variety is given in Table XL. The potatoes were planted May 8th at the rate of 680 pounds seed per acre.

Table XLI gives the averages of those varieties grown in 1893, 1895, and 1896. The variety test for 1894 is purposely omitted from this report.

Irrigation is not practiced on the Sundance farm, and consequently the potatoes were raised under conditions very different from those of the other farms.

TABLE XXXVIII.—*Sundance, 1893.*

No.	VARIETY.	Date ripe.	Date in bloom.	Ma- tured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve. <i>lbs.</i>
1...	Pride of the West	July 5	Sept. 15	135	59.2	7.5
2...	White Elephant	" 6	" 17	137	42.3	7.0
3...	Early Puritan	" 1	" 1	121	40.6	7.0
4...	Early Ohio	" 1	" 1	121	39.1	6.0
5...	Beauty of Hebron	" 1	" 1	121	34.8	6.0
6...	Early Mayflower	" 1	" 1	121	31.5	6.0
7...	Empire State	" 5	" 17	137	28.3	6.0
8...	Snow Drop	" 6	" 15	135	25.8	3.0
9...	Early Rose	" 1	" 1	121	22.9	5.0

TABLE XXXIX.—*Sundance 1895.*

No.	VARIETY.	Date in bloom.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve. lbs.
1.	Early Northern.	July 13	101	8.0
2.	Pearl of Savoy.	" 15	100	7.5
3.	Bill Nye.	" 15	90	9.2
4.	Early Sunrise.	" 15	90	9.3
5.	World's Fair.	" 23	89	8.7
6.	Vanguard.	" 15	85	7.7
7.	Empire State.	" 23	84	6.7
8.	Morning Star.	" 16	83	7.2
9.	Boston Red.	" 18	83	6.0
10.	Arizona.	" 18	81	7.7
11.	Pride of the West.	" 18	80	6.7
12.	Rochester Rose.	" 15	79	10.7
13.	Manitoba Rose.	" 19	77	8.0
14.	Burpee's Extra Early.	" 18	76	8.0
15.	Late Puritan.	" 18	76	7.5
16.	White Elephant.	" 23	76	7.3
17.	Polaris.	" 15	74	9.0
18.	Koshkonong.	" 23	73	7.5
19.	Alexander Prolific.	" 18	70	7.1
20.	Chas Downing.	" 18	70	6.2
21.	Snow Drop.	" 18	70	5.7
22.	Brownell's Winner.	" 23	69	8.5
23.	St. Patrick.	" 18	69	6.7
24.	Rose Seedling.	" 15	69	7.5
25.	Thornburn.	" 18	68	6.7
26.	Delaware.	" 18	66	7.5
27.	Summit.	" 18	66	7.7
28.	White Star.	" 23	66	6.7
29.	Early Minnesota.	" 18	62	7.0
30.	Reed's No. 86.	" 18	57	7.0
31.	Chicago Market.	" 18	54	9.2
32.	Clark's No. 1.	" 18	40	9.2
33.	Rural Blush.	" 22	39	6.0
34.	Acme Seedling.	" 23	34	4.5
35.	Dakota Red.	" 24	24	3.5
36.	Ohio Red.	" 23	22	5.7

TABLE XL.—*Sundance, 1896.*

No.	VARIETY.	Date in bloom.	Date ripe.	Ma- tured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve. <i>lbs.</i>
1.	Early Rose.....	July 13	Sept. 30	113	128	5.5
2.	Blue Victor.....		Oct. 2	115	121	5.5
3.	Chicago Market.....	" 15	" 5	118	98	5.0
4.	Freeman.....	" 18	" 2	117	87	5.0
5.	Early Six Weeks.....	" 18	Sept. 1	85	84	7.0
6.	White Elephant.....	" 13	Oct. 5	119	81	5.0
7.	Burpee's Extra Early.....	" 13	Sept. 8	91	80	7.5
8.	Burpee's Superior.....	" 13	Oct. 2	118	79	4.5
9.	Early Market.....	" 13	Sept. 15	97	78	8.0
10.	Morning Star.....	" 15	Oct. 7	120	78	4.0
11.	Empire State.....	" 18	" 5	118	76	4.5
12.	Alexander Prolific.....	" 18	" 5	117	75	5.5
13.	Ohio Junior.....	" 13	Sept. 8	100	75	8.2
14.	Albino.....	" 13	" 15	97	73	5.5
15.	New Queen.....	" 10	Aug. 30	82	73	7.0
16.	Brownell's Winner.....	" 21	Oct. 5	117	72	5.0
17.	Mammoth Pearl.....	" 18	" 2	115	72	5.5
18.	Monroe's Seedling.....	" 23	" 2	114	71	5.0
19.	St. Patrick.....	" 18	" 5	117	70	5.5
20.	Boston Red.....	" 10	Sept. 15	94	70	5.2
21.	White Star.....	" 23	Oct. 6	119	69	4.5
22.	Rural New Yorker.....	" 24	" 2	114	68	4.5
23.	Delaware.....	" 10	" 2	114	67	6.0
24.	Rose Seedling.....	" 14	" 5	125	67	6.0
25.	Clark's No. 1.....	" 16	" 1	114	64	6.0
26.	Early Sunrise.....	" 15	" 1	113	62	6.0
27.	Thornburn.....	" 24	" 5	117	57	5.5
28.	World's Fair.....	" 19	" 5	117	57	5.0
29.	Early Market.....	" 10	Sept. 15	97	56	5.5
30.	Snow Drop.....	" 18	Oct. 3	115	56	4.5
31.	Arizona.....	" 13	Sept. 30	113	55	5.0
32.	Manitoba Rose.....	" 13	Oct. 5	118	55	6.0
33.	Polaris.....	" 25	Sept. 15	99	55	5.0
34.	Reed's No. 86.....	" 25	Oct. 1	113	54	4.7
35.	Dakota Red.....	" 30	" 5	118	54	7.0
36.	Early Rose.....	" 17	" 1	112	54	6.5
37.	Pride of the West.....	" 17	" 7	113	52	5.0
38.	Koshkonong.....	" 24	" 5	117	50	6.0
39.	Rochester Rose.....	" 13	" 5	118	50	5.0
40.	Acme Seedling.....	" 23	" 8	120	48	7.0
41.	Chas. Downing.....	" 27	" 5	117	48	5.2
42.	Ohio Red.....	" 25	Sept. 15	97	47	5.0
43.	Vanguard.....	" 16	" 15	99	47	5.0
44.	Bill Nye.....	" 10	Oct. 6	120	45	5.0
45.	Summit.....	" 15	" 5	118	45	5.9
46.	Early Northern.....	" 15	" 1	114	38	4.5
47.	Pearl of Savoy.....	" 15	Sept. 30	109	36	6.0
48.	Rural Blush.....	" 25	Oct. 3	115	29	4.0
49.	Late Puritan.....	" 16	" 5	119	22	5.0

TABLE XII.—Average Potato Crop at Sundance for Two Years.

No.	VARIETY.	Average yield for two years in sacks of 1 cwt.	Average weight for 2 years of largest twelve.
			<i>lbs.</i>
1.	Morning Star	80.5	5.6
2.	Burpee's Extra Early	78.0	7.8
3.	Boston Red	76.5	5.7
4.	Early Sunrise	76.0	7.6
5.	Early Rose	75.5	4.4
6.	Chicago Market	75.5	7.1
7.	World's Fair	75.0	6.9
8.	Alexander's Prolific	72.5	6.3
9.	Brownell's Winner	70.5	6.8
10.	Early Northern	69.5	6.3
11.	St. Patrick	69.5	6.1
12.	Rose Seedling	68.0	6.8
13.	Pearl of Savoy	68.0	6.4
14.	Arizona	68.0	6.4
15.	Bill Nye	67.5	7.1
16.	White Star	67.5	5.6
17.	Delaware	66.5	6.8
18.	White Elephant*	66.4	6.4
19.	Manitoba Rose	65.0	7.0
20.	Vanguard	68.0	6.4
21.	Rochester Rose	64.5	7.9
22.	Polaris	64.5	7.0
23.	Pride of the West*	63.7	6.4
24.	Empire State*	62.8	5.7
25.	Koshkonong	62.5	6.3
26.	Thornburn	62.5	6.1
27.	Chas. Downing	59.0	5.7
28.	Summit	55.5	6.4
29.	Reed's No. 86	55.5	5.9
30.	Clark's No. 1	52.0	7.6
31.	Snow Drop*	50.6	4.3
32.	Late Puritan	49.0	6.8
33.	Dakota Red	44.0	5.3
34.	Acme Seedling	40.5	5.8
35.	Ohio Red	34.5	5.4
36.	Rural Blush	34.0	5.0

*Average for three years.

WHEATLAND.

In 1894 (Table XLII), the potatoes were planted May 7th in rows three feet apart. The land had been prepared by plowing under a crop of alfalfa while in full bloom the previous season. The potatoes were irrigated five times, the first on May 30th to bring them up.

In 1895 (Table XLIII), they were planted May 13th, in rows three feet apart, the seed was cut two eyes to the piece and dropped twelve inches apart in the rows. The land was alfalfa ground plowed in August, 1894.

In 1896 (Table XLIV), they were planted May 12th, in rows three feet apart, the pieces being dropped eighteen inches apart in the rows. This gave 248 pounds of seed to the acre. They were irrigated three times, the first on May 26th to bring up the crop.

Table XLV gives the averages for the three years.

TABLE XLII.—*Potatoes, Variety Test, Wheatland, 1894.*

No.	VARIETY.	Date in bloom.	Date ripe.	Ma- tured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve. <i>lbs.</i>
1.	White Elephant	July 10	Oct. 9	116	170.4	25.5
2.	Early Mayflower	" 10	Aug. 1	46	117.2	8.1
3.	Mammoth Pearl	" 25	Oct. 10	128	114.0	29.8
4.	Early Puritan	" 10	Aug. 15	61	108.7	16.0
5.	Early Rose	" 10	" 1	46	104.9	6.2
6.	Gov. Rusk	" 16	Oct. 10	117	90.3	21.1
7.	Vanguard	" 25	" 10	127	93.5	22.9
8.	Jumbo	" 18	" 10	127	88.9	20.5
9.	Hoffman	" 10	" 9	116	85.4	10.4
10.	Bill Nye	" 16	" 10	127	83.5	23.5
11.	Late Puritan	" 16	" 10	127	82.9	18.1
12.	Empire State	" 5	" 10	117	78.3	16.6
13.	Beauty of Hebron	" 25	" 10	127	77.9	12.0
14.	Snow Drop	" 10	" 9	116	73.9	18.6
15.	Triumph	" 18	" 10	127	72.0	23.5
16.	Rose Seedling	" 15	" 9	116	68.0	20.0
17.	New Burbank	" 25	" 10	127	67.3	20.2
18.	Early Ohio	" 10	Aug. 5	51	66.2	8.1
19.	Pride of the West	" 25	Oct. 10	127	65.0	17.4

TABLE XLIII.—*Potatoes, Variety Test, Wheatland, 1895.*

No.	VARIETY.	First bloom.	Last bloom.	Date ripe.	Matured in days.	Total yield in sacks of 1 cwt.	Per cent marketable.	Weight of largest twelve.
1	Rose Seedling	July 11	Aug. 10	Oct. 1	120	156.0	82.5	16.2
2	Rural New Yorker	" 10	July 27	Sept. 30	115	110.4	71.2	13.1
3	Early Mayflower	" 2	" 10	Aug. 24	83	104.4	71.9	11.0
4	Mammoth Pearl	" 12	" 20	Sept. 15	101	102.7	75.9	14.0
5	Late Puritan	" 8	" 23	" 30	112	89.7	71.7	8.5
6	Jumbo	Aug. 6	Aug. 15	" 19	105	84.5	80.0	10.7
7	Alexander Prolific	July 10	July 22	" 30	115	74.1	74.1	8.8
8	Hoffman	" 12	" 24	" 30	116	74.0	56.1	8.6
9	Clark's No. 1	" 15	Aug. 1	" 30	111	65.0	71.0	9.0
10	Early Rose	" 1	July 15	Aug. 10	69	64.3	74.7	8.9
11	Gov. Rusk	" 10	" 27	Sept. 30	120	61.8	70.5	9.2
12	Reed's No. 86	" 8	" 25	" 30	118	61.3	71.9	7.5
13	Morning Star	" 9	" 20	" 30	120	59.1	69.2	7.0
14	Boston Red	" 9	" 20	" 30	120	57.8	69.2	9.5
15	Empire State	" 9	" 20	" 12	102	55.2	58.8	13.1
16	Vanguard	" 9	" 29	" 30	116	53.3	69.5	11.4
17	White Elephant	" 12	" 24	" 20	102	52.8	76.7	13.7
18	Early Puritan	" 6	" 14	Aug. 15	74	49.4	68.5	6.5
19	Sunrise	" 7	" 12	Sept. 30	120	47.2	74.1	8.0
20	New Burbank	" 12	" 27	" 30	120	46.1	71.8	10.6
21	Hill Nye	" 8	" 20	" 30	116	44.2	63.2	6.6
22	Freeman	" 12	" 21	" 12	102	43.5	56.7	8.0
23	Polaris	" 9	" 15	" 30	111	42.9	77.3	8.4
24	Acme Seedling	" 12	" 20	" 30	112	41.6	75.0	7.0
25	Early Ohio	" 4	" 15	Aug. 24	83	39.7	83.6	8.5
26	Snow Flake	" 10	" 20	Sept. 30	116	39.0	50.0	7.9
27	White Star	" 12	" 25	" 30	111	38.3	62.7	6.5
28	Beauty of Hebron	" 11	" 24	" 30	116	35.8	80.0	9.0
29	Triumph	" 20	Aug. 1	" *	"	32.5	80.0	6.2
30	Pride of the West	" 12	July 25	Sept. 17	98	31.8	59.2	7.7

*Did not mature.

TABLE XLIV.—*Potatoes, Variety Test, Wheatland, 1896.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Length of vines.	Total yield in sacks of 1 cwt.	Per cent marketable.	Weight of largest twelve.
					<i>inches</i>			<i>lbs.</i>
1	Early Market.	July 20	Sept. 20	102	15	83.1	87.3	12.5
2	Early Minnesota.	" 15	" 15	90	14	72.7	81.0	10.0
3	Ohio Junior.	" 17	" 15	99	14	71.9	77.6	12.0
4	Sunrise.	" 15	Oct. 2	116	19	70.1	72.6	8.0
5	Manitoba Rose.	" 13	" 12	126	14	69.5	72.3	8.0
6	New Queen.	" 15	" 12	125	18	69.4	74.1	8.1
7	Burpee's Extra Early.	" 12	Sept. 5	89	15(?)	68.8	67.6	7.5
8	Ohio Red.	" 17	Oct. 12	126	17	67.0	72.2	7.2
9	Early Northern.	" 20	Sept. 15	99	13	66.9	71.4	8.5
10	Montana Wonder.	" 18	Oct. 12	126	24	65.1	80.0	9.0
11	Pearl of Savoy.	" 13	" 12	126	18	63.9	72.8	8.0
12	Delaware.	" 15	" 12	126	16	63.2	51.0	8.5
13	Monroe's Seedling.	" 14	" 12	109	16	63.2	56.9	8.0
14	Thornburn.	" 16	" 12	126	12	63.2	71.5	8.5
15	Rural New Yorker.	" 14	" 12	125	25	62.0	58.0	10.7
16	Rochester Rose.	" 18	" 12	124	17	61.4	65.6	7.0
17	Early Six Weeks.	" 15	Sept. 15	90	18	59.5	75.0	11.2
18	Alexander Prolific.	" 24	Oct. 12	124	16	58.9	50.5	7.4
19	Polaris.	" 20	" 12	126	24	58.0	64.1	10.0
20	Boston Red.	" 19	Sept. 18	101	12	57.7	52.7	8.2
21	Early Rose.	" 12	" 10	94	12	54.9	51.7	8.6
22	White Star.	" 17	Oct. 12	126	20	52.7	49.4	6.5
23	Burpee's Superior.	" 12	" 12	122	18	49.6	56.2	5.0
24	Clark's No. 1.	" 15	" 12	126	16	48.5	48.8	8.2
25	Early Ohio.	" 20	Sept. 12	95	12	48.4	68.4	7.7
26	Morning Star.	" 18	Oct. 12	126	22	48.4	57.7	6.6
27	Reed's No. 86.	" 18	" 12	126	21	47.1	64.5	7.1
28	White Elephant.	" 18	" 12	126	21	46.5	60.0	7.2
29	Arizona.	" 12	" 12	122	15	45.9	71.6	8.5
30	St. Patrick.	" 8	" 12	124	19	44.6	59.7	7.0
31	Koshkonong.	" 18	" 12	124	17	41.7	66.7	8.0
32	Vanguard.	" 18	" 12	126	17	39.1	60.3	6.6
33	Rural Blush.	" 18	" 12	124	26	39.0	00.0	1.0
34	Rose Seedling.	" 16	Sept. 18	102	17	38.4	68.1	13.1
35	Blue Victor.	" 15	Oct. 12	124	18	37.2	75.0	7.0
36	Empire State.	" 16	" 12	125	19	36.6	67.8	9.9
37	Early Sunrise.	" 15	" 12	124	15	35.2	63.0	7.8
38	Snow Drop.	" 18	" 12	126	23	33.3	63.0	7.5
39	Bill Nye.	" 22	" 12	124	24	31.0	00.0	3.0
40	Chicago Market.	" 19	" 12	125	20	29.8	70.9	6.5
41	Late Puritan.	" 15	" 12	126	22	28.1	49.8	6.1
42	Pride of the West.	" 20	" 12	126	20	26.7	53.5	6.5
43	Mammoth Pearl.	" 17	Sept. 15	99	12	25.4	65.8	8.1
44	Acme Seedling.	" 23	Oct. 12	126	14	22.1	69.1	7.1
45	Brownell's Winner.	" 17	" 12	126	23	18.9	00.0	0.8

TABLE XLV. — *Wheatland, Average for Three Years.*

No.	VARIETY.	Average yield in sacks of 1 cwt.	Average per cent market- able.	Aver- age weight largest twelve. <i>lbs.</i>
1.	Early Mayflower*	110.7		9.5
2.	White Elephant	93.2	68.3	15.5
3.	Rose Seedling	87.8	75.3	19.4
4.	Jumbo*	86.7		19.2
5.	Rural New York†	86.2	64.6	11.9
6.	Mammoth Pearl	80.7	71.9	17.3
7.	Gov. Rusk*	80.6		17.7
8.	Hoffman*	79.7		14.0
9.	Early Puritan*	79.0		11.3
10.	Early Rose	74.7	63.2	7.9
11.	Late Puritan	66.9	60.8	10.9
12.	Alexander Prolific†	66.5	64.3	8.1
13.	Vanguard	62.0	64.9	13.8
14.	Sunrise†	58.7	73.4	8.0
15.	Boston Red†	57.8	61.0	8.9
16.	Beauty of Hebron*	56.9		10.5
17.	Clark's No. 1†	56.8	59.9	8.6
18.	Empire State	56.7	63.3	13.2
19.	New Burbank*	56.7		15.4
20.	Reed's No. 80†	54.2	68.2	7.3
21.	Morning Star†	53.8	63.5	6.8
22.	Bill Nye	52.9	31.6	11.0
23.	Triumph*	52.3		14.9
24.	Early Ohio	51.4	76.0	8.1
25.	Polaris†	50.5	70.7	9.2
26.	Snow Drop	48.7	56.5	11.3
27.	White Star†	45.5	56.0	6.5
28.	Pride of the West	41.2	56.4	10.8
29.	Acme Seedling	31.9	72.0	7.0

*Grown only in years of '94 and '95.

†Grown only in years of '95 and '96.

Variety Notes.

Among any fifty varieties of potatoes selected from various seed catalogues it is very likely that there will be some duplicates. Careful study of all the varieties grown upon the home farm show a number which resemble closely and several which are undoubtedly duplicates.

Our field notes and careful comparison of the tubers show practically no difference between Chicago Market and Rose Seedling. Burpee's Extra Early and Thornburn seem identical. Acme Seedling and Early Market seem to be the same. Apparently there is not enough difference between Rochester Rose and Arizona to entitle them to separate names and Summit and Early Rose closely resemble each other. Koshkonong seems to be an improved Mammoth Pearl, the only apparent difference being larger yields from the former. Careful comparison of many other varieties fail to detect any important difference in the tubers themselves but differences in the plants, their season, and time of coming into bloom present sufficient variation to prevent further combinations. Old varieties are often given new names by ambitious seedsmen, perhaps after being improved, the new names aiding in advertising and selling to all those who are anxious to procure something new or better, than they already have.

The keeping qualities of the different varieties vary in much the same manner as the keeping qualities of different kinds of apples, though the variation is not so marked with potatoes. In general early varieties do not keep as well as late, but there is marked differences among the late varieties in this respect. We have experienced no difficulty in keep-

ing all kinds over winter. If not fully ripe when harvested they are apt to wilt. This was observed with Thornburn, Polaris, Freeman and Early Sunrise. The tubers of these varieties seemed ripe when dug but the tops were large and green up to the time of killing frost. The poorest keepers the past season were the Pearl of Savoy and Early Six Weeks. The other varieties which did not keep perfectly were Monroe's Seedling, Rural New Yorker, Arizona, Rochester Rose, Ohio Red, Delaware, Bill Nye and Albino. The other varieties have kept well. The one kind that can be depended upon to keep longer than any other on the list is the Blue Victor. On account of its color it does not sell well in many markets though in Sheridan County it is becoming quite a favorite. In a cellar or pit where the conditions of temperature and ventilation are favorable this variety may readily be kept for more than one season. The tubers are large, kidney or heart shaped, dark purplish or pinkish blue in color, often mottled with a lighter shade, skin tough, flesh very firm and, like a Ben Davis apple they, apparently never spoil.

VARIETIES.

We describe only a dozen varieties that have given the best yields at Laramie. These are the first twelve given in table XXVI on page —. Among the dozen and a half kinds in the table which follow this first twelve will be found many standard varieties which are good yielders. The greater number of the early sorts are near the bottom of the table.

Charles Downing:—Seed was obtained from Peter Henderson in the winter of '93 and '94. It is not a large potato but is of a fine shape for market, being oval elliptical, smooth and regular; skin is slightly roughened and dull yellowish white; eyes very small, few and shallow; medium late.

Delaware:—Seed from Vaughan's in the winter of '93 and '94. Potatoes of fair shape, large, long oval, flattened,

irregular and rather rough; skin rough, dull white; eyes medium in number and size.

Burpee's Superior:—Seed from Barteldes & Co., in winter of '93 and '94; size fair but shape rather poor for market; tubers long, round, tapering toward the ends and irregular; skin smooth, white; eyes medium in number and small; medium late.

Blue Victor:—Seed from Barteldes & Co., in winter of '93 and '94; tubers large and irregular, generally flattened, heart shaped; skin somewhat rough, purplish or pinkish blue with small dark purple specks and often mottled with lighter shades; eyes few, large and scattered, either shallow or prominent; good keepers and excellent shape for market; late.

Early Norther:—Seed from Peter Henderson in the winter of '93 and '94; tubers of good size and shape, elongated elliptical, flattened; skin smooth, pinkish white; eyes medium large and rather deep, pink especially at the seed end; early.

Morning Star:—Seed from Peter Henderson in the winter of '93 and '94; of good size, long oval, tapering slightly and flattened; skin yellowish white, rough; eyes large numerous and deep; medium late.

Manitoba Rose:—Seed was obtained from Northrup, Braslan, Goodwin & Co. in the winter of '93 and '94; pinkish white with darker pink shades at the ends, especially at the seed end; skin smooth and shiny; eyes large, numerous, and quite deep, with rudimentary leaf projecting over the eye pit; shape cylindrical, slightly tapering at either end, a fine looking potato; medium in season.

Alexander Prolific:—Seed was obtained from Vaughan's in the winter of '93 and '94; white with slightly bronze yellowish tinge, large, smooth, long oval, regular in shape, slightly flattened; eyes few, large but shallow; skin

speckled with numerous dark pin specks; medium early.

Monroe's Seedling:—Seed from Barteldes & Co., in the winter of '93 and '94; dull yellowish white, small cylindrical and regular; skin smooth with rather conspicuous flecks; eyes rather numerous and large but very shallow; late.

Boston Red:—Seed from Lee-Kinsey in the winter of '93 and '94; pink with white streaks; shape spherical or nearly so, regular; skin smooth with minute scattering flecks; eyes large, few, shallow, some protruding; medium in season.

Koshkonong:—Seed from Vaughan's in the winter of '93 and '94; dull yellowish white, dotted with minute flecks; large, oval shaped; flattened, regular, a fine shape for market; skin a little rough; eyes few, large, medium in depth; late.

Bill Nye:—Seed from Peter Henderson in the winter of '93 and '94; white, yellowish tinge, slight scattering pin specks; long, slightly flattened, tapering toward each end, regular, rather poor shape for market; eyes large, deep, with a rudimentary leaf projecting over the eye pit; skin smooth but not shiny; medium to late.

SUMMARY.

Soil Work:—At Lander potatoes on bottom land gave more than twice the yield that they did on upland.

At Sheriaden sub-soiled land gave 21 percent more yield than that not sub-soiled; at Sundance, 18.5 percent; and at Wheatland, 18.4 percent.

A gain of over 38 percent in yield was obtained by plowing under a crop of peas the previous season.

Insect Enemies and Diseases:—The potato beetle does no harm on the Laramie Plains, but is injurious in other parts of the state at lower altitudes.

The "Utah cricket" has done some damage at Lander.

The "potato maggot" is present on the Laramie Plains, but as yet no serious loss has been reported.

The treatment of potatoes for scab proved somewhat detrimental to the yield at Lander, but indirectly a great benefit to the yield at Laramie.

Preparing Seed:—The yield obtained from small potatoes planted whole has been greater than from large potatoes cut, but the percent of marketable tubers has been less from the whole or small seed.

Of the different methods of cutting the seed, that of quartering the tuber lengthwise and leaving part of the seed end on each piece gave the best results.

The rate of seeding per acre that proved best in each case was that amount which placed the sets eight inches apart in the row. Planting both closer and farther apart gave lower yields.

Potatoes at Different Altitudes:—The time between planting and harvesting the crop is almost identical at the differ-

ent altitudes in the state. Contrary to the general opinion the range of temperature is greater at lower altitudes than at higher.

The altitude apparently does not affect the yield.

The average specific gravity of the varieties grown at Sundance was 1.096 and at Laramie 1.081, during the season of 1896.

Planting, Cultivation, and Irrigation:—In the operations of planting precautions should be taken to conserve the soil moisture by preventing evaporation in every way possible.

High cultivation should be given, and the soil should be prevented from baking by cultivation between irrigations when possible. Too early irrigation should be avoided.

Yields, Cost and Profit:—The average yield for the state is from 100 to 150 bushels per acre. The largest authentic yield in the state is 974 bushels and 48 pounds.

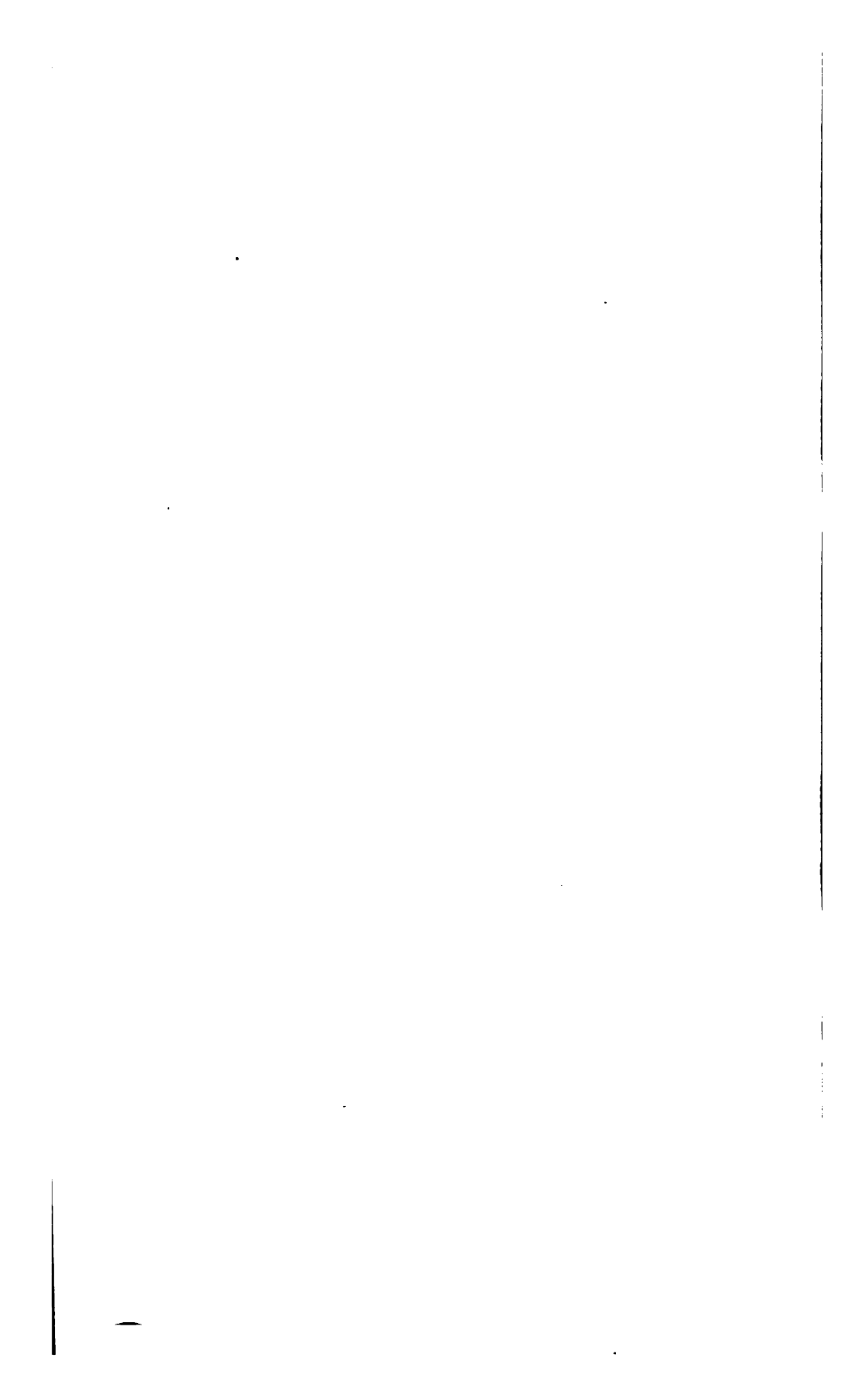
The average net profit per acre, from fifty varieties, for three years, at Laramie is \$31.15.

The average net profit per acre for two years at Lander is \$52.10.

The net profit per acre at Sundance for one year is \$37.50.

The average net profit per acre at Wheatland for three years is \$19.10.

The best keeper of all the varieties grown is the Blue Victor. In this respect it cannot easily be excelled.



UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,
LARAMIE, WYOMING,

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The Composition of Prepared Cereal Foods.

BY THE CHEMIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

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The Composition of Prepared Cereal Foods.

E. E. SLOSSON.

The introduction and extended use of the prepared cereal foods, ordinarily classed as "breakfast foods," amount to a veritable revolution in the food habits of the nation. Not many years ago the only foods of this character in use were hominy, rice and, later, cracked wheat. Oatmeal was almost unknown. Now, however, a great variety of cereal foods is in common use in almost all parts of the country and the market is flooded with package preparations of wheat, oats and corn, rivalling each other in ornateness of wrapper, novelty of name and ingenuity in advertising. The first foods of this character to be introduced were poorly prepared and required a long time and considerable skill to properly cook them but improved methods of milling have now produced many excellent cereal foods prepared for the table and already partly cooked. On account of the extravagance of the claims made for these foods and the wide difference in character and price it seemed desirable that some analyses should be made to show their real and relative value. Accordingly samples of all the prepared cereal foods to be found in Cheyenne and Laramie were purchased and analyzed with the results given in Tables I. and II.

EXPLANATION OF TERMS.

As this is the first bulletin issued from the Wyoming Experiment Station on the subject of foods a popular explanation of the meaning of the technical terms used and some discussion of the relative value of food constituents may be necessary.

Food is used in the body for two purposes, to supply the waste of the materials of which it is composed

and to supply the necessary energy for its operations and movements. To meet these two requirements by food which shall be of agreeable flavor and not excessive in quantity or cost is the unconscious object of our choice of food. The three most important constituents of food are protein, carbohydrates and fats.

Protein differs from the other two classes in that it contains nitrogen, one of the essential elements of the human body, which can only be obtained in this form. The proteid compounds are often called albuminoids and form the principal part of lean meat and egg albumen. If one chews a mouthful of wheat for some time without swallowing it there will be left a gummy mass known as gluten, the most important form of protein in grains. Protein is the most expensive of the constituents of food.

The carbohydrates include what we know as starches and sugars. They contain no nitrogen so cannot enter into the composition of the muscles of the body but they have about the same value as sources of energy as protein and, being the cheapest food, they constitute the principal part of our diet. The carbohydrates of cereals are mostly in the form of small hard starch grains which are not easily attacked by the digestive fluids. By cooking these grains are broken into powder and the starch is partly changed into the more soluble and digestible forms of dextrin and glucose. In prepared cereal foods the starch grains have been crushed and partly converted into soluble forms by means of heat, pressure and moisture, thus lessening the time needed for cooking. The amount of these soluble starches and sugars has been determined by dissolving them in cold water and is reported in a separate column from the carbohydrates insoluble in cold water. Fiber is the woody portion of the grain. It is entirely indigestible by man and is therefore separated from the nutritious carbohydrates, the sugars and starches. Although it is of no food value yet it is not ob-

jectionable in the small quantity found in prepared cereals and it is not certain that it would be of advantage to free food absolutely from indigestible matter.

Fats, under which term are included all the oily matter of the grains, are similar in composition to carbohydrates but are a more concentrated form of food since they give two and a half times as much energy to the body as the carbohydrates and protein.

The mineral or earthy matter of food is reported under the name of "ash" or the incombustible portion of the grain. It includes a large number of elements such as potash, soda, lime, magnesia, sulphur and chlorine which are necessary for both bone and flesh but as there is usually no deficiency in any of these the analysis need not be carried further. Phosphorus, which is partly included in the ash, is an element of such importance that special efforts are made in milling to secure it. It forms seventeen per cent of the mineral matter of the bones and the body of a man contains about a pound and a quarter of it.

The water in foods of course is of no value, but to make food absolutely dry would be both expensive and undesirable. As the percent of water is so variable it is difficult to see the relative values of different foods by comparing the percent given in the complete analysis. For that reason the analytical results have been calculated to a water-free basis in Table II.

Fuel Value.—The compounds of hydrogen and carbon, which form most of our food, are transformed by their use in the body into carbonic acid and water just as they are by burning in air, consequently the same amount of energy in the form of heat or labor is obtained from them by using as fuel in a stove or as food in the body. The chief use of food is to supply energy to our bodies for warmth and work and the amount of energy to be obtained from any kind of food can easily be determined by burning a sample of it un-

der such conditions that the amount of heat produced can be measured accurately. Nitrogenous foods are not consumed so completely in the body as by burning and therefore do not give quite so much energy but the difference is known and can be allowed for.

METHODS OF ANALYSIS.

The methods used in these analyses are those adopted by the Association of Official Agricultural Chemists with the few variations here noted. All determinations were made in duplicate except some of the ash, phosphorus and fuel value estimations. Air was used as a drying medium instead of hydrogen. The determination of water-soluble carbohydrates was made to estimate the amount of previous preparation or cooking the food had undergone. After a good deal of experimenting the following method was adopted which is rapid and sufficiently accurate for the purpose. Ten grains of the food were treated with 100cc of cold water in a stoppered wide-mouthed bottle, allowed to stand with occasional shaking for twelve hours and then for twelve hours without shaking, filtered through a folded filter and measured. To this solution which amounts to 50 or 80cc and usually gives a purple reaction with iodine, ten per cent of its volume of hydrochloric acid is added and it is heated on a boiling water bath (at a temperature of 93 degrees here) for two hours. Then it is neutralized, measured and the determination made with Fehling's solution. In this way a solution of the proper strength is obtained with evaporation. Duplicates made at different times agree to one-tenth per cent. The fuel values were determined by combustion in Mahler's bomb calorimeter. A description of the apparatus and the determination of its water value may be found in a special bulletin on "The Heating Value of Wyoming Coal and Oil," published by the University of Wyoming in January, 1895. Readings were made with a tele-

scope to one-thousandth of a degree. The oxygen was passed through a red hot tube to prevent traces of oil being carried over from the pump.* The fuel value as determined by the calorimeter is almost always a little higher (one to five per cent) than that calculated from the composition by the use of Stohmann's factors,† 4.2 for starch and cellulose, 9.5 for fats and 5.7 for protein. The factors for carbohydrates since they are of known substances easily extracted are probably correct and constant, that for fats is less so, while the factor for protein is based on very insufficient evidence and is undoubtedly wrong in some cases. With such foods as these it is probably too low, as 5.9 gives better results, but our knowledge of the proteids is too incomplete and our method of determining them too inexact to decide upon a constant, if such were possible. Calorimetric determinations are now exact enough to afford some guide to composition.

*Stohmann, Kleber und Langbein, *Journal für praktische Chemie*, 30, 513.

†*Zeitschrift für physikalische chemie*, 10, 410, and 6, 334. Experiment Station Record, 6, 590.

TABLE I.—Composition of Prepared Cereal Foods as Purchased.

No.	NAME.	Water, per cent.	Fat, per cent.	Protein, per cent.	CARBOHYDRATES.				Ash, per cent.	Phos- phorus, per cent.	Fuel Value, calories per gram.	Price per pound, cents.	
					Total per cent.	Soluble in water, per cent.	Insoluble in water, per cent.	Fiber, per cent.					
WHEAT.													
1	Wheatena.....	6.65	2.28	14.17	75.62	3.9	70.50	1.22	1.28	.363	4343	14.2	
3	Wheat Manna.....	9.65	1.49	16.60	70.71	3.5	65.91	1.30	1.55	.347	4203	8.9	
6	Pettijohn's Breakfast Food.....	9.51	1.45	10.56	76.96	2.8	72.15	2.01	1.52	.231	4174	7.6	
7	Farinose.....	6.34	3.72	14.71	73.78	4.0	68.34	1.44	1.45	.288	4437	10.3	
8	Farina.....	10.94	1.56	10.90	75.91	3.2	72.12	.59	.69	.153	4051	15.8	
9	Cracked Wheat.....	9.30	2.22	12.60	94.42	3.3	69.63	1.49	1.46	.333	4236	7.6	
10	Germae.....	9.52	2.07	9.37	77.38	3.2	73.62	.56	1.66	.168	4100	7.0	
13	Wheatlets.....	10.04	1.75	10.40	76.24	1.4	73.26	1.58	1.57	.357	4689	4.3	
14	Sioux Wheat Flakes.....	8.88	1.49	10.80	77.23	3.8	71.80	1.63	1.60	.311	4181	7.6	
16	Ralston Breakfast Food.....	9.72	1.90	15.10	71.75	4.6	65.60	1.55	1.53	.343	4158	11.2	
17	Durkee's Glutena Food.....	8.77	1.20	13.60	75.71	2.7	72.46	.55	.72	.251	4176	13.2	
18	Fould's Wheat Germ Food.....	10.13	1.46	13.30	73.93	3.7	69.35	.88	1.18	.326	4087	7.7	
19	Golden Sheaf Wheat Flakes.....	9.38	1.43	9.68	77.82	4.3	71.34	2.18	1.69	.395	3993	8.2	
OATS.													
4	Quaker.....	7.40	6.08	17.20	66.65	1.6	64.65	1.40	1.67	.341	4673	7.9	
5	Hornby's.....	7.63	7.35	17.82	65.47	1.3	62.74	1.43	1.73	.443	4756	12.8	
11	Cornack's Nudavene.....	6.56	6.36	17.55	67.78	2.9	63.56	1.32	1.75	.445	4617	5.0	
12	Buckeye.....	7.54	8.30	16.89	65.55	3.3	60.90	1.35	1.72	.416	4526	4.9	
15	Bulk.....	8.07	6.52	17.74	65.89	2.5	62.40	.99	1.78	.414	4665	2.5	
20	Douglas & Stuart.....	8.04	6.63	17.08	66.43	3.6	61.66	1.17	1.82	.447	4475	4.9	
CORN.													
2	Cerealine.....	9.55	1.24	9.90	78.75	7.1	70.93	.72	.56	.192	4542	9.2	
21	Velvet Meal.....	9.80	2.32	6.75	80.53	1.8	77.77	.96	.60	.185	3660	4.1	

TABLE II.—Composition of Prepared Cereal Foods Calculated as Water-Free.

No.	NAME.	Fat, per cent.	Protein, per cent.	CARBOHYDRATES.				Ash, per cent.	Phos- phorus, per cent.	Fuel Value, calories per gram.	Price per pound, cents.
				Total per cent.	Solu- ble in water, per cent.	Insoluble in water, per cent.	Fiber, per cent.				
WHEAT.											
1	Wheatena.....	2.44	15.18	81.01	4.2	75.50	1.31	1.37	.389	4652	15.2
3	Wheat Manna.....	1.65	18.37	78.26	3.9	72.92	1.44	1.72	.384	4652	9.9
6	Pettijohn's Breakfast Food.....	1.60	11.67	85.05	3.1	79.73	2.22	1.68	.255	4613	8.4
7	Farinose.....	3.97	15.71	78.77	4.3	72.93	1.54	1.55	.306	4737	10.9
8	Farina.....	1.75	12.24	85.24	3.6	80.97	.67	.77	.172	4549	17.7
9	Cracked Wheat.....	2.45	13.89	82.05	3.6	76.81	1.64	1.61	.367	4670	8.3
10	Germaide.....	2.29	10.36	85.52	3.5	81.40	.62	1.83	.186	4531	7.7
13	Wheatlets.....	1.94	11.56	84.75	1.6	81.39	1.76	1.75	.397	5212	4.7
14	Sioux Wheat Flakes.....	1.64	11.85	84.76	4.2	84.73	1.79	1.75	.341	4588	8.3
16	Ralston Breakfast Food.....	2.10	16.73	79.48	5.1	72.66	1.72	1.69	.380	4494	12.4
17	Durkee's Glutena Food.....	1.32	14.91	82.99	3.0	79.38	.60	.79	.275	4577	14.5
18	Fould's Wheat Germ Food.....	1.63	14.80	82.26	4.1	77.18	.98	1.31	.363	4547	8.5
19	Golden Sheaf Wheat Flakes.....	1.58	10.68	85.88	4.7	78.76	2.41	1.86	.436	4420	9.1
OATS.											
4	Quaker.....	6.57	18.57	75.06	1.7	69.85	1.51	1.80	.368	5046	8.5
5	Hornby's.....	7.96	19.28	70.88	1.4	67.93	1.55	1.87	.479	5148	13.8
11	Cormack's Nudavene.....	6.81	18.77	72.54	3.1	68.03	1.41	1.88	.476	4941	5.4
12	Buckeye.....	8.98	18.27	70.89	3.6	65.83	1.46	1.86	.450	4895	5.3
15	Bulk.....	7.09	19.31	71.67	2.7	67.90	1.07	1.93	.450	5074	2.6
20	Douglas & Stuart.....	7.21	18.57	72.24	3.9	67.07	1.27	1.98	.486	4866	5.3
CORN.											
2	Cerealine.....	1.37	10.95	87.06	7.9	78.37	.79	.62	.212	5021	10.2
21	Velvet Meal.....	2.57	7.48	89.28	2.0	86.22	1.06	.67	.205	4390	4.5

Description of the Foods.

The names of the foods analyzed and of the manufacturers are given below together with quotations from the advertisements setting forth the special claims of the preparations. The price given is the cost of a single package in Laramie or Cheyenne. When different stores charge different prices, as is frequently the case, the lowest price is taken.

No. 1. Wheatena, manufactured by Health Food Co., N. Y. "Made from white wheat, the bran coats are removed and by a peculiar process the starch is converted into a soluble substance. Can be perfectly prepared for the stomach by simply adding it to boiling water or to cold or hot milk without any cooking whatever. Rich in phosphatic elements, abundant in nitrogen, deficient in starch."

Size of package $4 \times 3 \times 5\frac{1}{4}$. Price 30 cents. Weight of contents 32.5 ounces.

No. 2. Cerealine Flakes. Cerealine Manufacturing Co., Columbus, O. "Prepared from pure white maize. Will cook in one minute." Package $5\frac{1}{2} \times 8\frac{1}{2} \times 5\frac{1}{2}$. Price 15 cents. Weight of contents 25.8 ounces.

No. 3. Wheat Manna. Centennial Mills, Spokane, Wash. "From the choicest white wheat; hulls removed, leaving pure white berry; easily digested; cook ten minutes."

Package $8 \times 4\frac{1}{2} \times 4\frac{1}{2}$. Price 15 cents. Weight of contents 26.8 ounces.

No. 4. Quaker Rolled White Oats. American Cereal Co., Chicago. "Owing to our peculiar methods of manufacture we do not sacrifice the sweetness and flavor of the oat for the sake of rapid cooking." "Boil twenty minutes or more."

Package 4x4x8 inches. Price 15 cents. Weight of contents 30.6 ounces.

No. 5. Hornby's steam-cooked three-minues Oatmeal. Manufactured by the Clover Mills, Buffalo, N. Y. "Analysis prove these Oats to possess a larger proportion of brain and muscle producing elements than any vegetable, flesh or other cereal food now used by man." "Analysis, Nitrates, 19.39, Carbohydrates 73.27, Phosphates 3.34, Water 4.00."

Package 3½x3x7½ inches. Price 25 cents. Weight of contents 31.2 ounces.

No. 6. Pettijohn's California Breakfast Food. American Cereal Co., Chicago. "From wheat, hulls carefully removed, leaving nutritious and no irritating parts." "Boil fifteen minutes or more."

Package 4½x4½x8 inches. 15 cents. Weight of contents 31.4 ounces.

No. 7. F. S. Parched Farinose. American Cereal Co., at F. Schumacher Mills, Akron, O. "Made from the best amber wheat, all nitrates, gluten and phosphates retained."

Package 2½x4x7 inches. 20 cents. Weight of contents 30 ounces.

No. 8. F. S. Pure Wheat Farinose. American Cereal Co., at F. Shumacher Mills, Akron, O. "Made from the most nutritious parts of wheat and is rich in gluten, nitrates and other properties necessary for the nourishment of the muscles, nerves and bones." "Boil ten minutes."

Package 1½x3x6 inches. 15 cents. Weight of contents 15.1 ounces.

No. 9. F. S. Cracked Wheat. American Cereal Co., at F. Schumacher Mills, Akron, Ohio. "Woody fiber and silex thoroughly removed." "Boil one to two hours."

Package 4x2½x7 inches. 15 cents. Weight of contents 31.4 ounces.

No. 10. Thatcher's Germade. Thatcher Milling and Elevator Co., Logan, Utah. "From Cache Valley White Wheat." "It contains more nutriment than any other article of food known." "Cooks in a few minutes."

Package 4x4x8½ inches. 25 cents. Weight of contents 54.2 ounces.

No. 11. Cormack's Patent Process Nudavene Flakes. American Cereal Co., Chicago. "Made from pure northern white oats, superior to any other oat product." "Cook in twenty minutes."

Package 4x4x8 inches. 10 cents. Weight of contents 31.8 ounces.

No. 12. Buckeye Rolled Oats. American Cereal Co., Chicago. "It is rich in nutritious quantities. Cooks in twenty minutes."

Package 4x4½x8 inches. 10 cents. Weight of contents 32 ounces.

No. 13. Wheatlets. Lindell Flour Mills, Ft. Collins, Colo. "Five-pound sack." 20 cents. Weight of contents 74.4 ounces.

No. 14. Sioux Wheat Flakes. Sioux Milling Co., Sioux City, Ia. "Made from California White Wheat." "Cook fifteen to 20 minutes."

Package 8x5x4 inches. 15 cents. Weight of contents 31 ounces.

No. 15. Oatmeal sold in bulk, Laramie. American Cereal Co. Ten pounds for 25 cents.

No. 16. Ralston Health Club Breakfast Food. Purina Mills, St. Louis, Mo. "The Ralston Health Club in analyzing the various breakfast foods on the market found one that proved to be the only perfect and by far the most healthful breakfast food in the country." "Cooks in five minutes."

Package 5x2½x7. 20 cents. Weight of contents, 31.6 ounces.

No. 17. Durkee's Glutena Food. E. R. Durkee & Co., N. Y. "Of the various elements composing wheat, the nitrates, viz., gluten and fiber, form about 15 per cent, the phosphates 2 per cent, the remainder consists of about 70 per cent of carbonate of starch and about 13 per cent of water." "Glutena consists entirely of the gluten and phosphates of wheat." "Boil ten minutes."

Package $3\frac{1}{2} \times 2 \times 6$. 15 cents. Weight of contents 18 ounces.

No. 18. Fould's Wheat Germ Meal. Daverio Process. Fould's Milling Co., Cincinnati. "It contains the best and most nutritious parts of the wheat."

Package $4 \times 2\frac{1}{2} \times 7$. 15 cents. Weight of contents 30.1 ounces.

No. 19. Golden Sheaf Wheat Flakes. Sprague Warner & Co., Chicago. "A healthy stimulant to nerve and brain forces as indigestible properties in the wheat are entirely removed."

Package $8 \times 4\frac{1}{2} \times 4\frac{1}{2}$. 15 cents. Weight of contents 28.9 ounces.

No. 20. Douglas and Stuart's Rolled Oats. American Flaked Oat Groats. American Cereal Co., Chicago. "Superior to any farinaceous goods in this line." "Partly cooked."

Package $5 \times 3 \times 8$, 10 cents. Weight of contents 32.4 ounces.

No. 21. Velvet Meal, Quail Brand. Nebraska City Cereal Mills, Nebraska City Neb. "One pound of properly prepared corn meal is more than equivalent to two pounds of fat meat."

Package $4 \times 3\frac{1}{2} \times 7$, 10 cents. Weight of contents 38.8 ounces.

Discussion of Results.

The chemical analyses and examination of the starch grains with the microscope showed no evidence of the presence of foreign cereals, so adulteration may be regarded as absent in foods of this class.

The packages are generally short weight but only in a few cases was there such a discrepancy between the actual weight of contents and that marked on the wrapper as to indicate an intentional fraud.

Leaving aside the customary claims of each food to be the best in the market and considering only the more specific statements of composition, food value, etc., it may be said that these are in many instances entirely unreliable and misleading as to the real character of the food. When the general public becomes better educated on the subject of foods we may expect advertising to take the form it already has taken in many other industries, that of an attractive and intelligent presentation of the real merits of the article. If purchasers of goods in packages and cans would always note the brand and afterwards buy according to the quality, it would be a good encouragement to honest manufacturers and the grade of such foods would no doubt be raised. The chief advantages of package goods is that the manufacturer is made directly responsible to the consumer.

It will be seen that there is more variation in price than in composition, and that there is no discoverable relation between quality and price. Some articles are four or five times the cost of others of the same class and apparently of the same merit. It is quite evident who pays for the beautiful advertisements that form the bulk of our magazines. At the same time it is not the most extensively advertised foods that are the dearest. The oatmeal sold in bulk is practically

the same in composition and, so far as can be judged by personal taste, in quality and flavor as that sold in packages for several times the price. Of course in buying bulk articles one is not so sure of getting the same grade or that the quality has not been injured by long keeping and exposure.

The claims made for quick cooking are generally fallacious. Almost all such preparations should be cooked for at least half an hour and usually longer to insure the complete digestibility of the starch. Except in the case of corn the addition of milk or cream is not needed to supply any deficiency in the foods. Sugar should be used only as a condiment. Most people in the United States eat so much sugar as to quite unbalance a ration already excessive in carbohydrates.

The question that will probably be asked by most people who read this bulletin "Which is the best food?" is one that cannot be answered. There is no "best food." The three grains used have each distinctive and useful qualities. Oatmeal contains more of the valuable ingredients, protein and fat, than the other two and approaches closely in composition to a correctly balanced food. These facts do not, however, exclude the use of wheat and corn preparations which are to many preferable. All that such a bulletin as this can do is to give the data on which the judgment of the reader can form his own estimates of the relative merits of the foods analyzed. Human food is generally selected on account of flavor and this as a question of taste is outside the bounds of discussion. The important question of digestibility and wholesomeness is also one which every man must settle with his own stomach. The older investigations on this subject are quite misleading. Not every man has a stomach like Alexis St. Martin's or Brown-Sequard's, still less like a test tube in a water bath. Recent experiments are giving more reliable results but individual differences are so important that the choice of food cannot be ultimately

decided by the application of general principles. About 85 per cent of the protein, 90 per cent of the fat and 98 per cent of the carbohydrates in cereals are digestible.* Composition cannot be taken as a perfect guide to the real value of a food. One series of experiments on the digestibility of whole wheat flour and fine flour showed that a less amount of the valuable constituents was digested from the whole wheat than from the fine flour although the former was superior in composition.† The popular articles in the newspapers on dietics are for the most part misleading, either because they are premature judgments based on insufficient data or because they are written in favor of some food fad. Those interested in the subject may get reliable information from the bulletins of the Department of Agriculture at Washington and reports of experiment stations and kitchens. [Farmer's Bulletin No. 23 on "Foods, Nutritive Value and Cost," Farmer's Bulletin No. 34 on "Meats; Composition and Cooking," Bulletin No. 24, Office of Experiment Stations on "Chemistry of Food." Also magazine articles by Prof. Atwater and others as in the Century for June, 1897.]

*Report of Storrs Agricultural Experiment Station, 1896, p. 188.

†Chemie der menschlichen Nahrungs- und Genussmittel, Koenig, Vol. I. p. 43.